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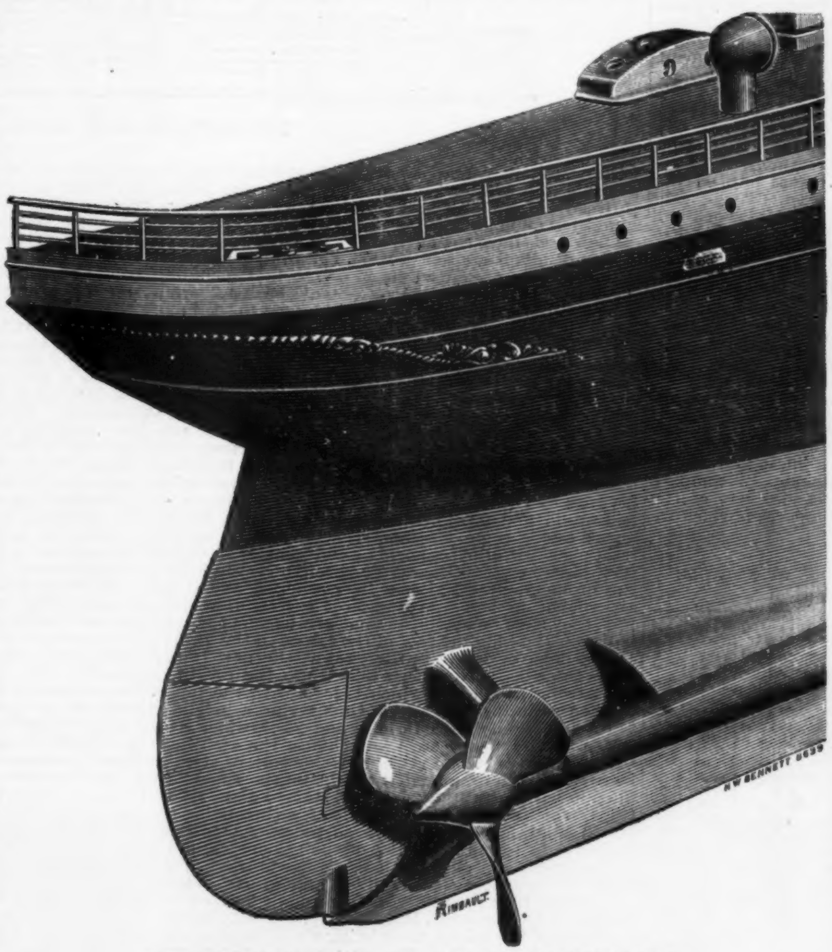
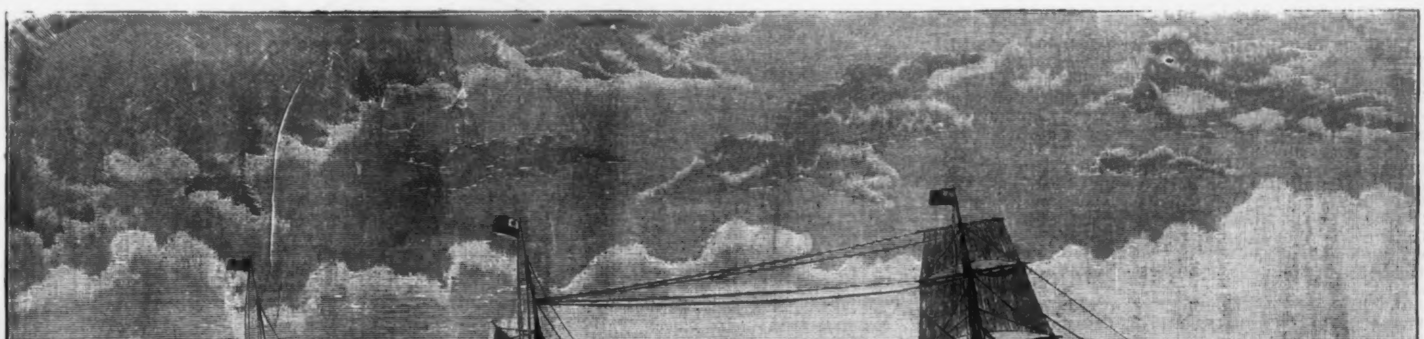
THE INMAN STEAMER CITY OF NEW YORK.

WHEN the first steamship ventured to start from England for America, to face the stormy seas of the North Atlantic, those responsible for the step scarcely dreamed of the advance which would be made in fifty years, a progress well represented in the two magnificent vessels soon to be sent forth from Messrs. James & George Thomson's shipbuilding establishment on the Clyde, to sail on the Atlantic under the flag of the Inman and International Steamship Company. The first of these vessels—the City of New York—was launched March 15, and we now place before our readers some particulars of this important addition to our Atlantic liners.

To enable the reader to fully appreciate the action of the Inman company in having the City of New York and her sister vessel built, we shall give an epitome of the history of the Atlantic trade. Although the practicability of vessels crossing the Atlantic without the aid of sails had been previously demonstrated, it was not till 1840 that a regular mail service by steamships was established, the Cunard company owning the fleet, and from that year to this a continuous contest for supremacy has been engaged in. For nearly ten years the Cunard liners were without opposition; but in 1850 the Collins company (American) and the Inman company were inaugurated, the latter making a good start by having their first vessel—the City of Glasgow—built of iron and propelled by a screw instead of paddles—two departures which were then experimental, but which have since been approved by practice and adoption. This opposition had such an effect in stimulating the companies to increased diligence that in six years, in 1856, the "record" was reduced from 15 to 12½ days. In 1856 the Anchor and Allan lines entered the field, and in 1858 the Collins line ceased to run vessels, the competition being too keen for their balance sheets. Still more new companies entered the lists, the North German Lloyd's in 1858, followed three years later by the French Compagnie Transatlantique. In 1863 the National line was established, in 1866 the Guion line, which had previously run sailing packets, and in 1870 the White Star line. With such a host of companies one can well understand the rivalry that existed, and that it fostered trade and stimulated engineers and shipbuilders. In 1875 the Inman company made a bold move, and had built the City of Berlin, then the largest passenger steamer afloat, her length being about 500 ft.; breadth, 44 ft.; depth, 36¼ ft.; the gross tonnage being 5,481, and the indicated horse power of engines 4,800. Her chief competitors were the Britannic, Germanic, Gallia, and Arizona, the record standing then at 7 days 8 hours. The size of vessels was, at that time, materially increasing, and a 6,000-tonner was not looked upon with the same astonishment as five years previously. The power of the engines placed in passenger ships, too, was growing enormously great; yet the time taken for the journey was not very considerably reduced. Rivalry between the companies increased with years, and no sooner had a steamer been beaten than her owners excited the zeal and skill of naval constructors to produce a vessel likely to beat all afloat. This was practically the reason why in 1880 the Cunard line commissioned Messrs. James & George Thomson to build the Servia, while the Guion line ordered from Messrs. John Elder & Co. the Alaska, and the Barrow company were intrusted with the construction of the City of Rome. The latter vessel was unprecedentedly large, her length being 546 ft., and her tonnage 8,141 tons. She, however, failed to come up to expectations on her trial, but had her engines and boilers overhauled with the desired effect. The records of these three vessels in 1882-83 were: Alaska, 7 days 4 hours 10 minutes; Servia, 7 days 6 hours; and City of Rome, 6 days 22 hours. Even before the Servia was out of hands, the Cunard company contracted with Messrs. Thomson for the vessel named Aurania, and although her guaranteed speed was one-half knot per hour under that of the Servia, yet she crossed the Atlantic at a faster pace. At the same time Messrs. Elder turned out for the Guion line the Oregon, and a year later the National liner America was constructed by Messrs. Thomson. The latter vessel in her maiden voyage broke the record, being the first steamer that had done so on a first trip, her journey taking 6 days 13 hours. In this connection it may be mentioned that the America was remarkable for the small consumption of coal, consequent upon her fine form, which enabled her to be very easily driven. She was a very marked departure, her builders having profited by the experience gained in high speed war ships. She only burned 175 tons of coal per day, whereas her principal competitors consume 300 tons. Coming to still newer vessels, the Umbria and Etruria, Cunard liners, built by Messrs. Elder, have proved themselves the fastest on the Atlantic. Their speedy voyages across the ocean created great excitement, each successive trip for a time being faster than its predecessor. In the America they had a close second; and since she was sold to the Italian government as a cruiser, they have been followed closely by the North German Lloyd's and the French Transatlantique steamers. The Umbria and Etruria are at present



THE RUDDER, WITH ONE OF THE PROPELLERS.



THE NEW INMAN STEAMSHIP CITY OF NEW YORK—10,500 TONS.

supreme, their records being 6 days 4 hours 34 minutes, but how long they will continue so is problematic, for not only are the new Inman liners intended to steam as fast as they do, but two White Star liners being built by Messrs. Harland & Wolff, of Belfast, are also intended as competitors for first place. Such contests as that to be engaged in six or eight months hence must be welcomed, because they not only stimulate trade, but quicken the intellectual researches of constructors and give them an opportunity of making material progress in the development of their profession. As an instance of the truth of the former assertion it need only be stated that whereas fifty years ago passengers were incidents in the journey, there are now 150,000 passengers (exclusive of emigrants) passing to and fro on the Atlantic every year.

The City of Rome, intended originally for the Inman line, did not come up to expectations as regards speed, although, as we have already said, she has been considerably improved. She is now worked by the Anchor line, and holds a good position among the other Atlantic steamers. Her failure threw the Inman line out of the running for a long time, and when the company was broadened into the Inman and International Steamship Company, it was decided to have two vessels built which would place that company in the creditable position previously held. Many builders submitted designs of "probable" vessels, and latterly, in the spring of 1887, Mr. Griscom, one of the directors of the Inman company, came from America, and, with the directors on this side—Messrs. Taylor and Spence—entered into negotiations with Mr. James R. Thomson, senior partner of Messrs. James & George Thomson, shipbuilders, with the result that an agreement was entered into for two vessels. All the particulars of the design were left to the builders, the only conditions laid down by the Inman company being that the vessels were to be unsinkable, as comfortable as any hotel, and as speedy as it was possible to make them consistent with the first two considerations. The expectation is that the vessels will equal any on the Atlantic. The designer felt that a speedy and safe ship must of necessity be a long and large one, but there was a limit imposed by the size of docks, their widths of entrance, and draughts of water—considerations which were kept in remembrance in fixing the dimensions of the new vessels. These dimensions are as follows:

Length on load water line.........	525	ft.
Length over all....................	560	"
Breadth.............................	63¼	"
Depth moulded.....................	42	"
Tonnage (gross)....................	10,500	tons.

These figures show that the vessels are the largest passenger carrying steamers in the world, and in view of the speed to which they are to attain, it may not be uninteresting to show how their dimensions compare with those of other notable Atlantic steamers of the present and of bygone days, a comparison which we give in tabular form.

TABLE GIVING CHIEF DIMENSIONS OF NOTABLE ATLANTIC LINERS.

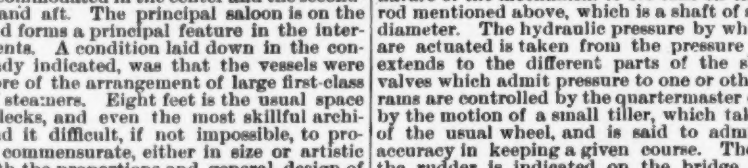
	Built.	Tons.	Length. ft.	in.	Beam. ft.	in.	Depth. ft.	in.	Proportion of Beam to Length.	Proportion of Depth to Length.
*Great Western....	1835	1,340	212	4	35·4		23 2		5·99	9·15
*Great Britain......	1841–3	3,500	274·2		48·2		31·5		5·08	8·70
†City of Glasgow....	1850	1,600	227		32		24		7·09	9·45
†Britannic..........	1874	5,004	455		46		34		9·89	13·38
†City of Berlin......	1875	5,491	488		44		36¼		11·90	13·46
†Gallia..............	1879	4,809	430		44		36		9·77	11·94
†Arizona............	1879	5,147	450		45	2	37½		9·96	12·00
‡Servia..............	1881	7,392	515		52		40¾		9·90	12·62
†Alaska	1881	6,932	500		50		39	7	10·0	12·63
†City of Rome......	1881	8,141	546		52		58¾		10·5	9·29
‡Aurania...........	1882	7,269	470		57		39		8·24	12·05
†Oregon.............	1883	7,375	500		54		39¾		9·25	12·57
‡America............	1884	6,500	432		51		37½		8·47	11·52
‡Umbria and Etruria	1884	7,718	501·6		57·2		38·2		8·76	13·13
‡Saale...............	1885	5,381	455		48		36	3	9·47	12·55
‡Lahn...............	1887	5,681	465		49		36½		9·48	12·83
‡City of New York and City of Paris.	1888	10,500	500		63		42		8·80	13·09

NOTE.—Those marked * were built of wood, † of iron, and ‡ of steel.

We must now return to the vessel ready to be launched. The keel of the City of New York was laid in June last, and that of the companion ship, the City of Paris, shortly afterward. The vessels are constructed of steel made at the works of the Steel Company of Scotland, Newtown and Blochairn, and at the Mossend Steel Company's works. The material placed in position, when the ships were almost ready for launching, weighed, for each vessel, 7,000 tons, the heaviest casting for each ship being the stern post of 26 tons. The heaviest casting for the engines weighs 50 tons. The steel was thoroughly tested at the makers, under Lloyd's supervision, and has been carefully treated by a special process to remove as much as possible the chance of corrosion. The vessels have been built throughout on the most approved principles of modern ship construction, and in many respects bold innovations, based on exhaustive scientific experiments, have been introduced. They are intended to be classed at Lloyd's, and have, therefore, been watched, during their design and construction, by the chief surveyor at Lloyd's, Mr. Benjamin Martell, and his assistants-in-chief, Messrs. Cornish and Edwards, while the local superintendence, with its many small details, has been left in the hands of Mr. Courtier-Dutton.

The sketch of the longitudinal section shows that the hull of each vessel is divided by transverse bulkheads into fifteen water tight compartments, including three for boilers and two for machinery, the latter being separated by a longitudinal bulkhead. The doors in the bulkheads are on the upper deck far above the load water line, it being determined not to trust to the doors being promptly shut in cases of danger. None of the compartments exceeds 35 ft. long, and the quantity of water they hold to load water line is 1,250 tons, or to upper deck 2,250 tons. Even were two or three filled, the flotation of the vessel would not be placed in danger, and her buoyancy could easily be trimmed. As an additional precaution, the vessel has two bottoms, the space between them being 4 ft. They serve a double purpose, for not only will the existence of an inner bottom insure that no part of the ship will be flooded by a fracture of the external bottom, but the space can be utilized for carrying water ballast to the extent of 1,600 tons for adding to the stability or altering the trim of the ship.

One other noteworthy principle of the internal arrangements of the vessels may be mentioned. Their dimensions, fortunately, are not likely to cause them to roll badly, as do some other large Atlantic steamers; but to provide for the possibilities of occasionally meeting seas which may make them roll, they will each be provided with a rolling chamber, similar in character, though much improved in form, to that which has been fitted in some of our large war ships, to reduce their excessive rolling. This rolling chamber is really a large tank inside the vessel, extending from side to side, and 35 ft. in length, and partially filled with water. The partial filling enables the water to move about freely, and when the dimensions of this chamber and its form are properly selected, the motion of the water can be made to counteract the motion of the ship when rolling. The constructors have, after a long series of experiments, both on models and in actual Atlantic work, arrived at a form of chamber which will reduce the rolling by at least one-half. To such as are affected by *mal de mer*, this provision will be welcome, and will banish from their minds the feeling of dread which makes many who are desirous of voyaging stay on land.



THE CITY OF NEW YORK.

The vessels have each five decks, as will be seen from the longitudinal section given. The total number of square feet on each deck is 27,000, so that including the bottom of the hold, the vessels have each a flooring of over 150,000 square feet. The deck next to the hold, called the orlop deck, will be, with the spaces below, devoted to cargo carrying. The next two—the lower and main decks—are devoted to passengers, the first-class being accommodated in the center and the second-class forward and aft. The principal saloon is on the main deck, and forms a principal feature in the internal arrangements. A condition laid down in the contract, as already indicated, was that the vessels were to partake more of the arrangement of large first-class hotels than of steamers. Eight feet is the usual space between two decks, and even the most skillful architect would find it difficult, if not impossible, to produce a saloon commensurate, either in size or artistic treatment, with the proportions and general design of such large vessels. Messrs. Thomson, however, solved this problem in the National liner America, and as the experiment in her case was most successful in every way, they have repeated the same arrangement greatly improved, making the roof of the saloon in the form of a large dome or arch. In the case of the new Inman liners three decks have been taken into the height of the saloon, the dome of which is level with the top of the houses on the upper deck, thus giving a height of 22 ft. The dome is 53 ft. long and 25 ft. wide. It is supported by heavy steel stanchions, the arch itself being formed of strong yet light framework of steel, to be covered with ornamented wood, and the spaces are filled in with beautifully designed stained glass 1½ in. thick, which will be quite capable of withstanding the North Atlantic blasts. The arch presents a most imposing sight from the interior of the saloon, making it roomy, clear, and cheerful looking, in contrast to the close and depressing effect which an ordinary saloon, no matter how finely decorated, usually has on the passengers. The arch, large as it is, is not the complete size of the saloon, there being a number of alcoves so arranged that small parties may dine together in comparative seclusion. On the next, the upper deck, there is a promenade at each side, about 10 ft. in width, and extending for about four-fifths of the length of the vessels. The deck above shelters it. The space between the two decks is occupied by houses, which contain the principal public rooms of the ship, general saloon, ladies' saloon, smoking rooms, etc., and about thirty-five staterooms, all most artistically adorned. The exposed or weather deck above will be known as the promenade. It extends unbroken from stem to stern. On it is a long house with the best passenger rooms, about twenty-five in number. When the vessels are running with their full complement on board, they will not contain less than 2,000 people each. The enormous amount of woodwork in the ship may be appreciated when it is stated that 120,000 cubic feet of timber of all kinds, and from almost all parts of the earth, have been used for each vessel, the weight being 1,300 tons.

THE SALOON.

The rudder fitted to these vessels is of a novel description, recently patented by Messrs. Thomson & Biles—Mr. James R. Thomson, senior partner of the firm, and Mr. J. H. Biles, manager of the shipbuilding department. It has been specially designed, in the first place, for use in war ships, where it is a most vital consideration to keep the whole of the steering gear below the water. We herewith illustrate the arrangement. The rudder is formed so as to be a continuation of the lines of the vessel. It is a structure built up of steel plates and angle bars, and of sufficient strength to resist the exceptionally heavy strains that will come upon it on account of its large area of 250 square feet, a surface greater than has yet been adopted even in ships of war. The strains upon the rudder and steering gear will, however, be greatly reduced on account of a part of the surface being on the forward side of the axis of the pintles. The machinery for turning this rudder is on the hydraulic principle introduced by Mr. A. Betts Brown, Edinburgh, and consists essentially of two hydraulic rams, which are placed one on each side of an ordinary tiller. The plungers of these rams work in a direction at right angles to the tiller, and are connected to a sliding block which can slide backward and forward upon the arm of the tiller. Thus while the rams have a simple reciprocating motion the tiller has a corresponding angular motion, which is transmitted to the rudder by a massive connecting rod connected by a simple pin joint to a short tiller on the rudder head. In designing the steering arrangements for these vessels, it has been considered desirable to make them thoroughly efficient for war purposes in the event of the ships being used as armed cruisers, a condition which is not by any means fulfilled by the steering gear fitted to ordinary merchant steamers. The gear, which we have described, is powerful enough to put the rudder hard over when the ship is going full speed ahead, each hydraulic ram being capable of exerting a thrust of 80 tons, which is increased by the nature of the mechanism to 140 tons on the connecting rod mentioned above, which is a shaft of steel 12 in. in diameter. The hydraulic pressure by which the rams are actuated is taken from the pressure main, which extends to the different parts of the ship, and the valves which admit pressure to one or other of the two rams are controlled by the quartermaster on the bridge by the motion of a small tiller, which takes the place of the usual wheel, and is said to admit of greater accuracy in keeping a given course. The position of the rudder is indicated on the bridge by a simple arrangement.

The City of New York and her companion are to be propelled by twin screws. Twin screws have been adopted for war ships, and in several merchantmen; but, strange to say, none of the first-class Atlantic liners have double propellers. It must, therefore, be placed to the credit of the Inman company that they have been the first to adopt both the single and the twin screws in the Atlantic trade. The propellers are supported by two massive steel stays, each of which is a casting of steel weighing 26 tons and made by the Steel Company of Scotland.

The machinery consists in each vessel of two sets of engines of the three-crank triple expansion type, having piston valves throughout. Each set of the engines is capable of exerting sufficient power to propel the vessel at four-fifths of her maximum speed, so that should one set break down no serious delay will take place, for the vessel will go at a speed, say, of 16 knots instead of 19 knots per hour. The dimensions of the engines and boilers we must leave to be given at a future date, but we may say that in the engines steel castings have been freely used in place of cast iron, and ample bearing surfaces have been provided for high speed running. The machinery has been inspected during its construction by Mr. Parker, chief engineer surveyor of Lloyd's, while Mr. Doran, superintending engineer of the Inman company, has carefully watched the operations on behalf of the owners. The machinery is placed between two transverse water tight bulkheads, and a water tight partition running longitudinally divides the engines—the port from the starboard. The boilers from which steam is supplied are similarly safeguarded. They are fitted in three separate water tight spaces, divided by transverse bulkheads.

The auxiliary engines of each of the vessels number thirty-seven, the majority of which are driven by hydraulic power, the apparatus being by Messrs. Brown Brothers, Edinburgh. For hoisting the cargo in and out of the vessels, hydraulic machinery is supplied. There are nine cargo holds, some of which have two hoists to lift the cargo from the hold and swing it over

the side noiselessly. The rattle of steam winches will be entirely absent, and those who have slept, or tried to sleep, on board of a steamer the night before her departure, will thoroughly appreciate this change. Hoists for many other purposes are fitted in the vessels, such as lifting the food from the galleys to the pantries, the stores from the storeroom to the galleys, the engineers and firemen from the bottom of the vessel to the different levels on which they are to work, and the ashes are also hoisted from the boiler rooms to the main deck and put through a tube to the sea without any noise. In all there are ten hydraulic hoists and twelve hydraulic derricks The steering of the vessels is also, as already stated, effected by hydraulic power, actuated by a powerful ram capable of developing a thrust of 80 tons. The vessels will be fitted throughout with an installation of the electric light. More than 1,000 incandescent lamps have been supplied to each. The machinery is completely duplicated, so that any breakdown will not place the ships in darkness. The whole apparatus has been fitted by Messrs. King, Brown & Co., Edinburgh.

The external appearance of the ships is certainly very smart, and when placed alongside of bygone ships the comparison shows that, in addition to improvement in the motive power of the vessels, their symmetry of form has also been greatly enhanced, and that naval construction is now not only a science, but also an art. They will have three masts, 200 feet from keel to ball, or 150 feet above the top deck. The foremast will be square rigged and the other two fore and aft. Between the fore and main masts are three funnels standing with a gentle slope 60 ft. above the top deck. Immediately in front of these is the bridge deck. A prominent feature of the exterior of the vessels is the large number of lifeboats ranged on either side. Consistent with the principle that the first consideration should be given to safety, these vessels are fitted with complete lifeboat accommodation for every soul on board, and though it is anticipated that there is practically no chance of the ships having to be abandoned, yet the fact that such a contingency is possible has been properly faced, and the boats and their lowering arrangements have been worked out in the most careful manner to insure rapid handling in an emergency and the safety of all on board. With the clipper stem, fine sheer, and overhang at stern, the vessels will have a well balanced appearance.

The City of Paris will be launched about a month hence, and they will be completed and ready for sea by the early autumn.

The appearance the City of New York will present when at sea is shown by the engraving, while the smaller views illustrate the saloon and the rudder, with one of the propellers. It will be seen that the external tube which carries the propeller shaft is supported by a bracket in the usual way, and, in addition, by a stiffening web.—*Engineering.*

FLEET OF THE HUDSON RIVER ICE YACHT CLUB.

Yacht.	Owner.	Length. Center Timber Over all.	Length. Rudder Post to Center of Runner Plank.	Beam.	Area of Sails. Square Feet.	Rig.	Class.	Port.
ARCTIC	N. P. Rogers	29.	14.	15.3	383	Sloop	3d	Hyde Park.
ARIEL	Archibald Rogers	26.	15.	16.	253	Sloop	4th	Hyde Park.
ARROW	Lewis Edwards	31.11	16.7	18.	369	Sloop	3d	Roosevelt Point.
AVALANCHE	E. Harrison Sanford	49.2	26.7	26.8½	825	Sloop	1st	Roosevelt Point.
BESSIE	N. P. Rogers	35.	19.	20.	485	Sloop	2d	Hyde Park.
BLIZZARD	T. Newbold	39.	21.1	24.	560	Sloop	2d	Hyde Park.
BOREAS	Irving Grinnell	44.	24.	20.10	620	Sloop	1st	New Hamburgh.
CYCLONE	J. R. Roosevelt	32.1	16.1	16.	417	Sloop	3d	Hyde Park.
DASHAWAY	Robert R. L. Clarkson	23.3	11.8	12.6	220	Sloop	4th	Tivoli.
DREADNOUGHT	W. Cary Sanger	38.3	21.	19.10	525	Sloop	2d	Brooklyn,
FAIRY	Lewis Edwards	34.5	12.6	11.3½	248	Sloop	4th	Roosevelt Point.
FLASH	James Reynolds	31.	10.	12.6	217	Sloop	4th	Poughkeepsie.
FLIRT	J. Hopkins and C. Parker	25.	12.	11.	150	Sloop	4th	Hyde Park.
FLYING CLOUD	Irving Grinnell	53.	32.	21.6	610	Cat	1st	New Hamburgh.
GALATEA	Robert R. L. Clarkson	32.2	17.9	17.4	410	Sloop	3d	Tivoli.
GRACIE	Lewis Edwards	37.8	19.1	18.6	493	Sloop	2d	Roosevelt Point.
GREAT SCOTT	E. Harrison Sanford	35.7	17.2	20.6	499	Sloop	2d	Roosevelt Point.
GRACE	G. E. Buckhout	36.	14.	17.	374	Sloop	3d	Poughkeepsie.
ICICLE	J. A. Roosevelt	48.10	26.3	25.1	735	Sloop	1st	Roosevelt Point.
ISIS	G. A. Bech	23.7	13.8½	13.	181	Sloop	4th	Poughkeepsie.
JACK FROST	Archibald Rogers	47.5	26.	25.	728	Sloop	1st	Hyde Park.
NORTHERN LIGHT	J. C. Barron	43.2	23.	25.3	680	Sloop	1st	Roosevelt Point.
ONTEORA	Herman Livingston	33.1	17.4	20.	443	Sloop	3d	Catskill.
PUFF	Irving Grinnell	28.2	14.	13.	200	Sloop		New Hamburgh.
POLARIS	J. C. Barron	36.6	19.6	20	441	Sloop	3d	Roosevelt Point.
REINDEER	G. A. Bech and W. Kane	48.10	26.	26.	731	Sloop	1st	Hyde Park.
SNOW-BALL	P. C. Rogers	38.9	19.2	18.6	493	Sloop	2d	Hyde Park.
SNOW-FLAKE	E. P. Rogers	38.	19.	18.	444	Sloop	3d	Hyde Park.
ST. NICHOLAS	E. P. Rogers	42.6	23.5	24.	679	Sloop	1st	Hyde Park.
WHISTLER	Irving Grinnell	38.	19.6	16.6	375	Sloop	3d	New Hamburgh.
WHIFF	Irving Grinnell	31.7	15.9	15.6	360	Sloop	3d	New Hamburgh.
ZERO	Irving Grinnell	48.6	25.9	25.7	750	Sloop	1st	New Hamburgh.

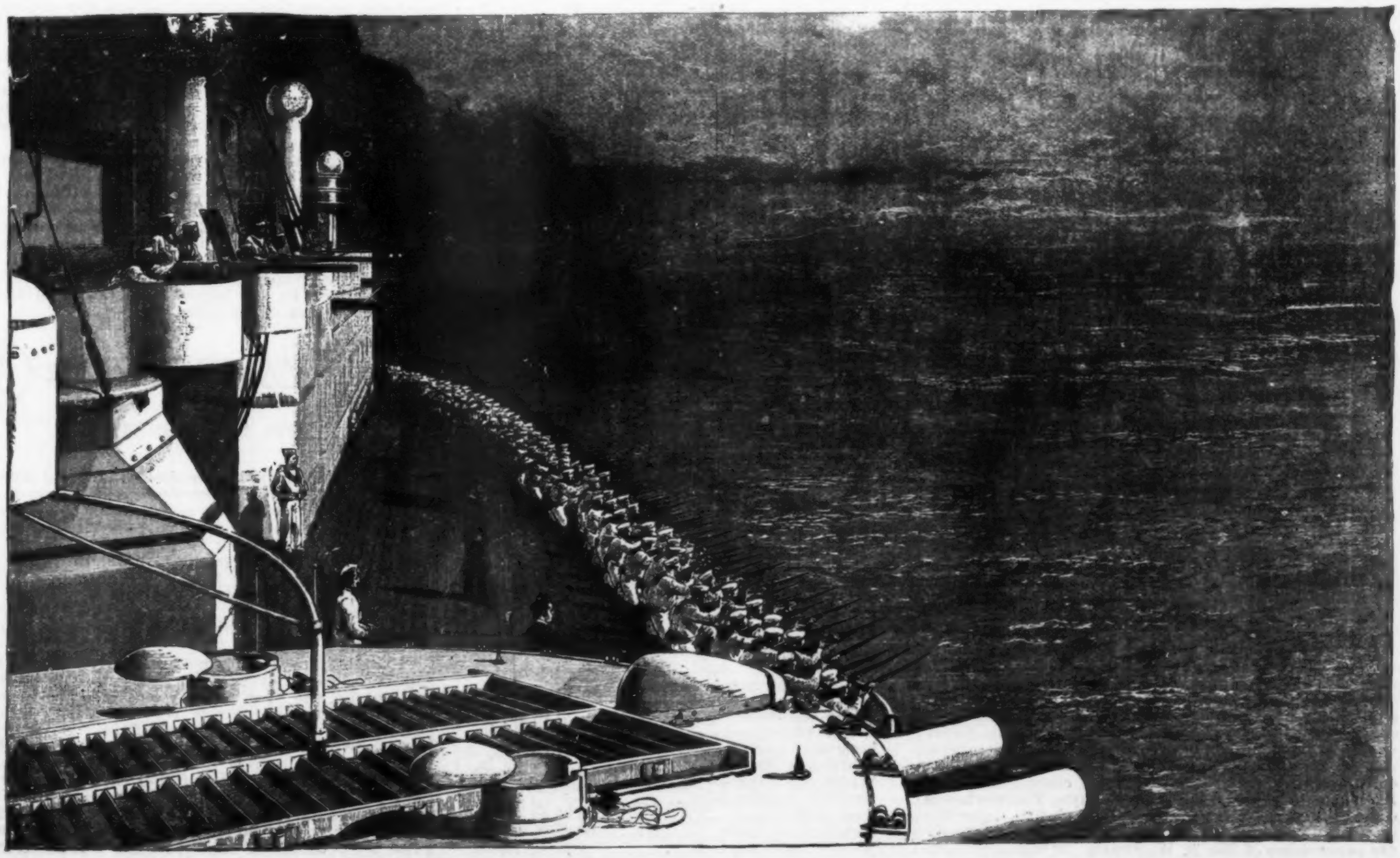
H. M. S. EDINBURGH AT TORPEDO PRACTICE.

OUR engraving is from photographs by an officer on board H. M. S. Edinburgh while in the Mediterranean. Her crew are preparing to give an attacking torpedo boat a very warm reception with machine guns and Martini-Henry rifles, and it would be marvelous in real warfare if the tiny craft ran the gauntlet unscathed of all these deadly weapons, which would shower countless bullets on her the moment she came within range. H. M. S. Edinburgh is a fine type of the modern war ship, and is fitted with all the latest novelties and death-dealing appliances which nineteenth century ingenuity has succeeded in producing. She is the most powerful vessel now afloat of the British navy, and was commissioned for the Mediterranean fleet in November, 1887, by Captain H. B. St. L. Palliser. The Edinburgh was laid down at Pembroke, in 1879, as the Majestic, and was launched on March 18, 1882, being then renamed the Edinburgh by the Duchess of Edinburgh. Her length is 346 feet, her beam 68 feet, and her tonnage amounts to 9,305. Her armament consists of four 12 inch 45 ton breech-loading guns, five 6 inch 5 ton guns, and eighteen machine and quick-firing small guns. She is sheathed with eighteen inches steel faced compound armor.—*London Graphic.*

HUDSON RIVER ICE YACHTS.

WE are indebted to the Hudson River Ice Yacht Club for a copy of its constitution, by-laws, sailing regulations, etc. We find in it the following enumeration of the fleet belonging to members of the club. It is safe to say there is not to be found in any quarter of the world a swifter lot of boats than these. They embody all the latest improvements in sails, rig, and other details of construction. The working drawings for building these modern ice boats were given in our SUPPLEMENT, No. 624.

THE number of ships which passed through the Suez Canal last year was 3,137, their gross tonnage being 8,430,043 tons. Two thousand three hundred and thirty ships were English; France, 183; Germany, 159; Italy, 138; Holland, 123; Austria (and Hungary), 82; Norway, 28; Spain, 26; Russia, 22. Only 3 American vessels used the canal in 1887.



TORPEDO PRACTICE—H. M. SHIP EDINBURGH.

ON A TRIAL OF A WATER TUBE BOILER AT SIBLEY COLLEGE, CORNELL UNIVERSITY.

By R. H. Thurston.

Introduction.—It was thought by the writer desirable, some time since, to secure a high pressure steam boiler for use at the Sibley College of Cornell University, for the special purpose of supplying steam for experimental purposes, and to drive, at times, the engines to which the dynamos used in the course of the work in electrical engineering were attached. For all ordinary purposes of simple lighting and everyday use, the water power derived from a turbine at the fall in the stream adjacent to the college is found amply sufficient, both in power and regularity of speed; but for the finer work of the course of instruction and for nice electrical measurement, a more perfectly regular speed is demanded, and this could only be obtained by the use of a well constructed steam engine. The engine commonly used is a "Straight-line engine," a type originally designed at Sibley College by its inventor, Professor Sweet, the performance of which engine has been described in earlier papers. The water wheel employed is a "Hercules" wheel of 12 inches in diameter, and under 42 feet head, at a speed of about 600 revolutions per minute. Westinghouse, Brayton, and other engines are employed for less exacting work; although the former is often found to give excellent satisfaction even for lighting purposes.

It was intended to purchase, as it became advisable to secure more boiler power or to displace old boilers by new ones, a variety of the best known boilers, especially of the "safety" class, and to thus have the means of comparing the several designs of boilers in the market and to make the student familiar with their distinguishing characteristics of design and construction, and with their management. The first boiler purchased was that which forms the subject of this paper --a Babcock & Wilcox boiler, rated at 60 horse power. A trial was made of this boiler at the close of the last college year, to determine whether it came fully up to its rating in power and in economy. The work was done by Messrs. G. A. Covell and H. E. Smith, under the general direction of the writer and under the immediate supervision of Mr. A. W. Smith. It was very carefully and skillfully done and the results reported are interesting as showing what excess of power has been given above the rated capacity of the boiler, and what good firing may do in giving at once great power and high economy.

At the time of making these experiments, only the simple form of calorimeter here described was available for use. Since then a Webb calorimeter, a Barrus, and other forms have been arranged in a calorimeter room next the boiler room of the new laboratory building recently erected, and a comparison of these several types is thus made possible. The performance of the simple tank calorimeter, on this occasion, handled as it was with great care and exceptional skill, was such as to leave little to be desired; as may be seen from the uniformity with which data obtained by the observations made with it run. The average is probably very accurate, and shows that the pushing of the boiler up to a power exceeding its rated capacity by nearly forty per cent. caused no priming and gave practically dry steam. The analysis of the flue gases was made by Mr. Smith. The method adopted as well as the details of the trial are given in the following account of the work so fully as to demand no other explanation here.

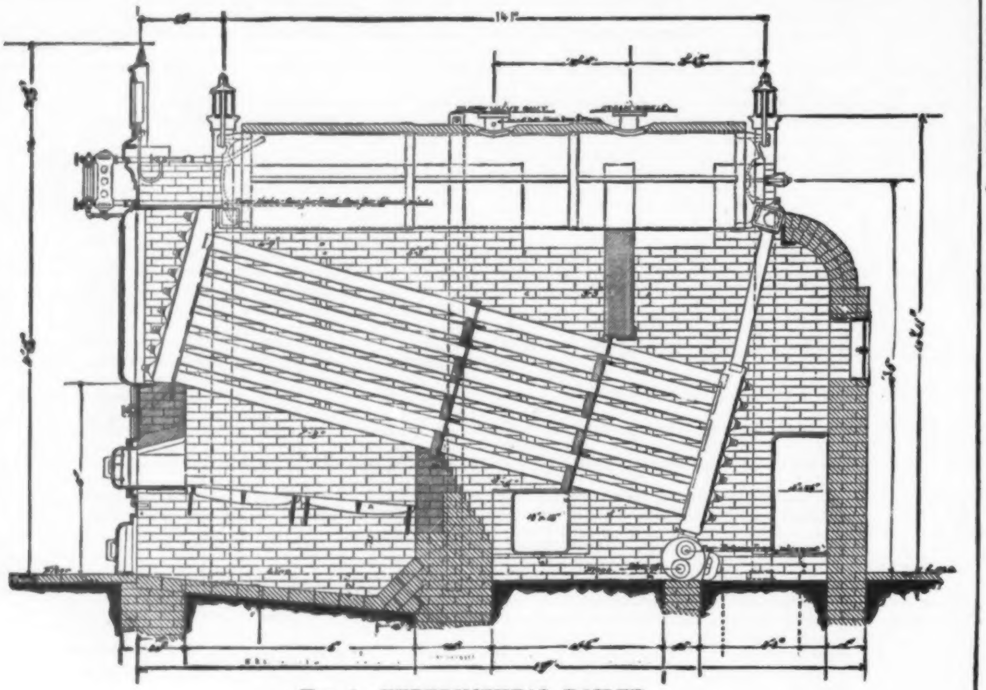


Fig. 1.—EXPERIMENTAL BOILER.

TRIAL OF THE BABCOCK & WILCOX BOILER AT SIBLEY COLLEGE.

This boiler was used to supply steam to one or more engines, as needed, or to heat the buildings of the college. The general arrangement of boiler and setting, which is independent of the other boilers, is shown in Figs. 1 and 2. The principal dimensions are as follows:

Length of drum	13 ft.
Diameter	2 ft. 6 in.
Number of water tubes	40
Outside diameter of tubes	4 in.
Length	13 ft. 8 in.
Width of furnace	3 ft. 3½ in.
Length of furnace	6 ft. 1 in.
Length of grate bars	3 ft.
Width of grate bars	¾ in.
Width of air spaces	¾ in.
Number of grate bars	54
Area of chimney	3·65 sq. ft.
Height of chimney	60·25 ft.
Area of grate surface	20 sq. ft.
Area of heating surface	682·57 sq. ft.
Area of draught between tubes	4·75 sq. ft.
Ratio of grate to heating surface	1:34·1
Ratio of draught area to grate	0·25
Ratio of grate surface to cross section of chimney	5·48
Ratio of area of grate to area of air spaces	2·24
Whole area of damper opening	3 sq. ft.

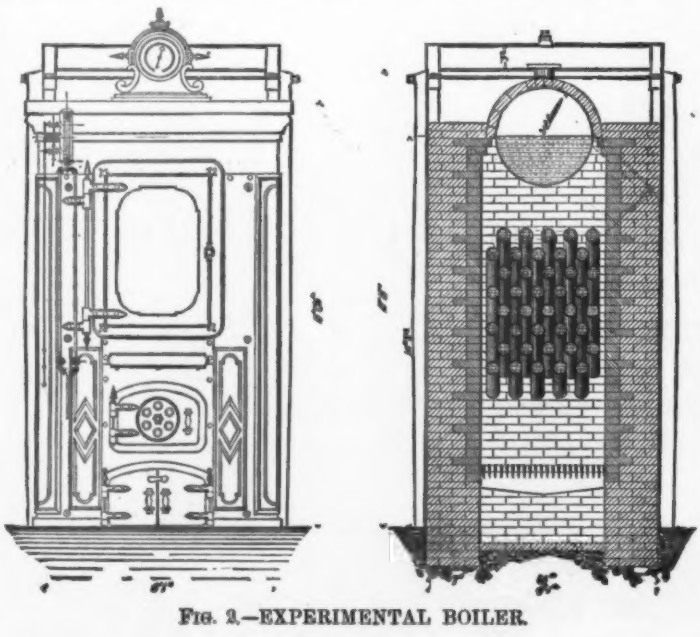


Fig. 2.—EXPERIMENTAL BOILER.

The main steam pipe after passing horizontally to the rear of the "setting" descends vertically a distance of 4 ft. and passes out of the boiler room to the chimney. Draught is produced by a chimney which rises directly at the back end of the boiler, the first 9½ ft. being brick and the remainder a sheet iron cylindrical stack. A vertically sliding damper is placed in the opening leading to the chimney. Two partitions of fire brick supported by iron plates are placed transversely across the nest of water tubes. The first is 7 ft. 1 in. from the front end of the tubes, and the second 3 ft. 7 in. from the first. These partitions cause the gases to pass among the tubes three times, then across the rising tubes into the back connection, and from there to the chimney.

The object of the trial was: 1st. To determine the evaporative efficiency of the boiler. 2. To estimate the horse power developed under ordinary working conditions, a horse power being taken as equivalent to 30 lb. of feed water supplied per hour at a temperature of 100° Fahr. and evaporated under 70 lb. gauge pressure.

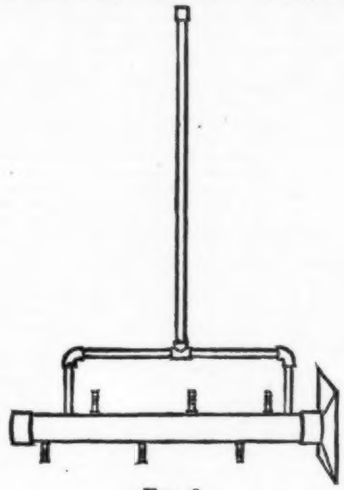


Fig. 3.

Previous to the test all cracks and holes in the setting and around the doors leading to the flues were carefully stopped with fire clay and mortar. The blow-off and return "drip" pipes were disconnected and caps placed on the exposed ends. An injector feed pipe connected with the boiler was left in place, as its disconnection would be attended with some difficulty. The overflow pipe was, however, left open, in order to detect any leak which might occur. The feed pipe was disconnected from the "mains," and a suction pipe from it placed in a barrel into which the feed water was run after having been weighed. A pipe leading to the outside of the boiler house was connected with the main steam pipe, so that all steam made by the boiler, over and above that required to run the engine and heat the buildings, could be discharged into the air.

At 7 A. M. April 28, the fire, which had been banked on the preceding evening, was started, and the steam pressure brought to 80 lb. by the large gauge. The fire was then quickly drawn and the contents of the ash pit removed. A new fire was started immediately with a weighed quantity of hemlock wood and brought to the normal condition with coal. The amount of water shown by the water glass was noted. At 8 A. M. the engine was started, and the trial commenced. Both ash pit doors were left open at first and the damper wide open. The damper was lowered 3 in. at 9:30 A. M. and at 12:50 a further amount of 3 in. At 11:17 A. M. one of the ash pit doors was closed and so remained during the remainder of the trial. The effect of this arrangement of damper and draught door was observed in the higher temperature of the flue gases at the base of the chimney.

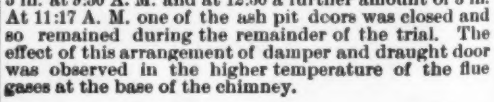


Fig. 4.—PYROMETER.

The analysis of the gases showed no great difference in their composition. The fuel used was anthracite coal, known in the market as "grate coal." An average sample of this coal was weighed, pulverized, and placed in an evaporating oven to dry. After 7 hours it was found to have lost 3·81 per cent. in weight. In working up the results of the trial, this figure was taken to represent the percentage of moisture in the coal. The coal was weighed by the barrow load in uniform charges of 200 lb. each, and dumped before the door as needed.

The stoking was performed regularly every half hour and fire cleaned every third time. During the period of stoking, the back damper was closed to avoid loss of heat by the current of cold air which otherwise would rush through the heated flues. The feed water was drawn from the mains into a barrel placed on a platform scale, where it was carefully weighed. It was then drawn off into another barrel, from which it was pumped into the boiler by a Davison steam pump of the ordinary type. It was the endeavor to deliver the water to the boiler as continuously as possible. The temperature of the feed water was noted at each weighing.

The following observations were made every half hour.

Temperature of flue gases at the base of chimney.
Temperature of boiler room.
Temperature of outside air.
Reading of draught pressure gauge.
Readings of the several steam gauges.

The pyrometer which was used in measuring the temperature of the flue gases had previously been compared with a mercury thermometer between temperatures of 213° F. and 322° F. This was accomplished by means of a simple apparatus shown in Fig. 4. The stem of the pyrometer was inclosed in a steam pipe which has communication to the boiler through a smaller pipe fitted with a stop valve. The thermometer used in the comparison was also screwed into the larger pipe. As steam was admitted the mercury rose and soon registered a temperature corresponding to the steam pressure, which was kept constant for several minutes until the pyrometer reading no longer changed.

Both readings were noted and more steam admitted, giving a higher temperature.

The several readings were "plotted," and the law of variation of the pyrometer from the thermometer reading was found to be approximately a straight line (Fig. 5), continually falling below and diverging from the line representing the temperature as read from the thermometer.

The pyrometer was corrected from this curve, and is believed to be approximately correct.

The draught pressure gauge, which was attached to the stack near the base, was made for the Sibley College laboratories by the Hartford Steam Boiler Insurance Co. It consisted of a U-tube partially filled with water and provided with a movable vernier and scale for measuring the difference in level of the water in the two arms.

An Edson recording steam gauge and Shaw mercury gauge were attached to the boiler in addition to the large gauge ordinarily used.

The mercury gauge was taken as the standard, and the others corrected by it.

The result of the comparison of the Edson recording gauge with the mercury gauge when subjected to hydraulic pressure is given on the cross section paper in Fig. 6, below.

Calorimeter.—Experiments were made every hour to determine the quality of the steam. A well made barrel which had been thoroughly shellacked inside was placed on a standardized Fairbanks platform scale, made for this work, the beam of which was graduated to $\frac{1}{10}$ of a pound and provided with a sliding poise.

The scales were very sensitive, and a greater error than $\frac{1}{10}$ of a pound could hardly be possible on any one reading.

The steam was taken from the main steam pipe about 1 ft. from its connection with the boiler, and was conducted to the calorimeter through a ½ in. pipe, 9 ft. long, to the end of which was attached a piece of rubber hose 7 ft. long. The pipe was covered with hair felt to prevent radiation of heat. Before placing the end of the hose in the calorimeter, steam was allowed to blow through until all the water of condensation had been discharged and the pipe and hose were thoroughly warmed up. The end of the hose was given an inclination downward toward the bottom of the barrel by means of a light strip of wood fastened to it. The steam passing into the condensing water at an angle produced a strong agitation, and thus a thorough mixture of the water was effected.* A standard Centigrade thermometer, graduated to tenths of one degree was used with the calorimeter, and the readings were afterward reduced to the Fahrenheit scale.

* Probably, on the whole, as good an arrangement as any plan involving the use of stirring apparatus.

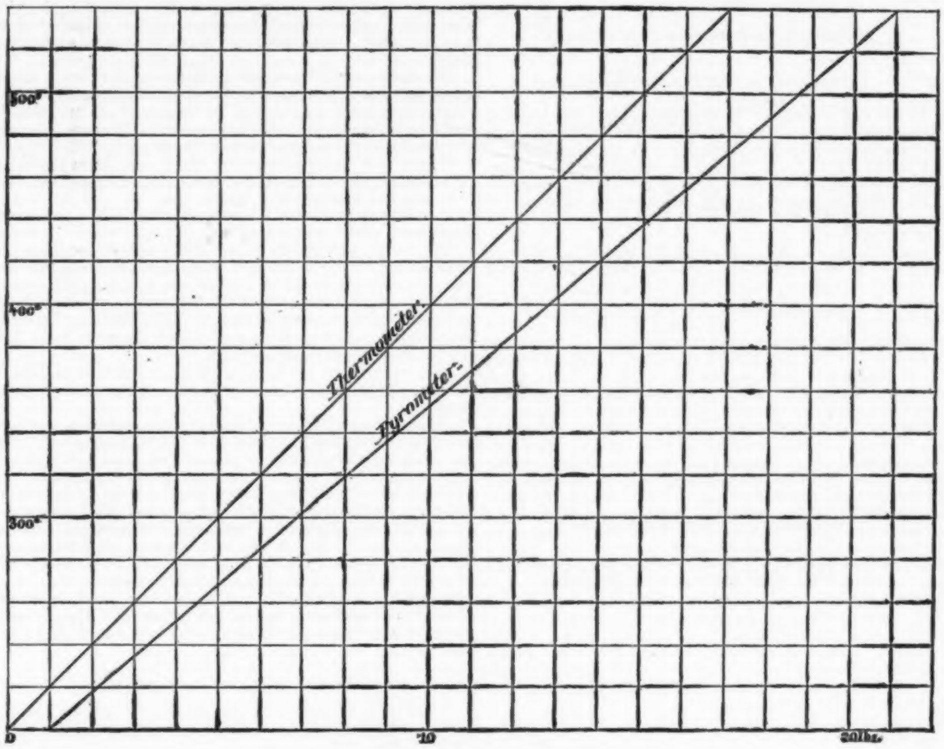


FIG. 5.—TEMPERATURES.

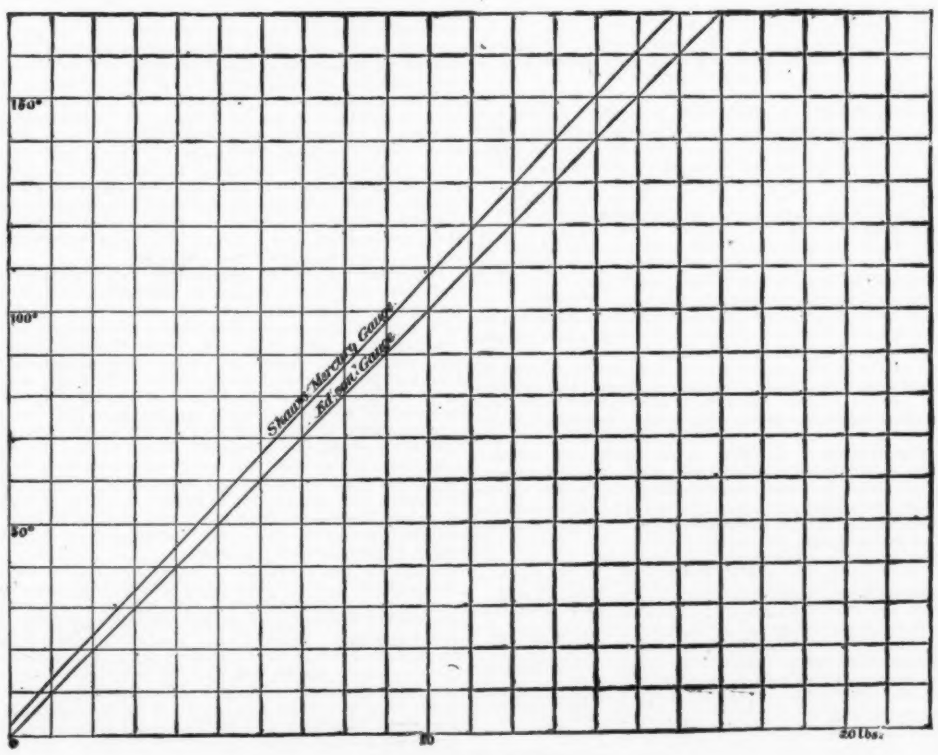


FIG. 6.—PRESSURE.

Gas Analysis.—During the trial five samples of flue gas were taken for analysis. The tabulated results of the analysis are as follows:

PER CENT. BY VOLUME.

No.	Time.	CO_2, Observed.	Free O, Observed.	CO, Calculated.	N, Calculated.
1	8:30 A.M.	12	5·2	4·6	78·13
2	10:20 A.M.	12	6·7	2·16	79·13
3	12:20 P.M.	11·1	7·9	1·6	79·3
4	2:20 P.M.	11·7	6·8	2·5	79
5	4:20 P.M.	11·5	7	2·5	79

BY WEIGHT.

No.	Time.	CO_2, Calculated.	Free O, Calculated.	CO, Calculated.	N, Calculated.
1	8:30 A.M.	17·56	5·5	4·33	72·62
2	10:20 A.M.	17·52	7·07	2	73·40
3	12:20 P.M.	16·27	8·39	1·95	73·86
4	2:20 P.M.	17·11	7·19	2·32	73·38
5	4:20 P.M.	16·83	7·41	2·32	73·44

No.	Time.	Per Cent. by Weight, Total O.	Per Cent. by Weight, Total C.	Air Supplied, Per lb. C.	$\frac{\text{Free O}}{\text{Combined O}}$
1	8:30 A.M.	20·74	6·65	14	0·36
2	10:20 A.M.	20·96	5 64	16·7	0·51
3	12:20 P.M.	21·31	5·27	18	0·64
4	2:20 P.M.	20·95	5 66	16·6	0·52
5	4:20 P.M.	20·97	5·58	16 9	0·54

Professor Elliott's apparatus, Fig. 7, was used for the analysis. For the absorption of CO_2 a solution of potassic hydrate (1 to 20) was used, and for oxygen absorption, potassic pyrogallate; this latter being prepared by adding 5 per cent. of pyrogallic acid to a solution of potassic hydrate (1 to 8). Numbers 1 and 2 were tested for CO with cuprous chloride, but as none was absorbed, and it was evidently present, the amount was calculated as follows:

For No. 1, we have 12 per cent. CO_2, whose volume is

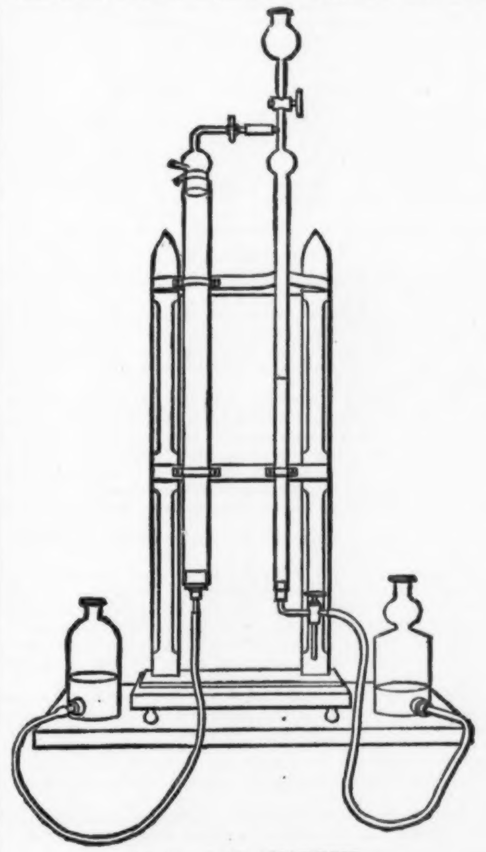
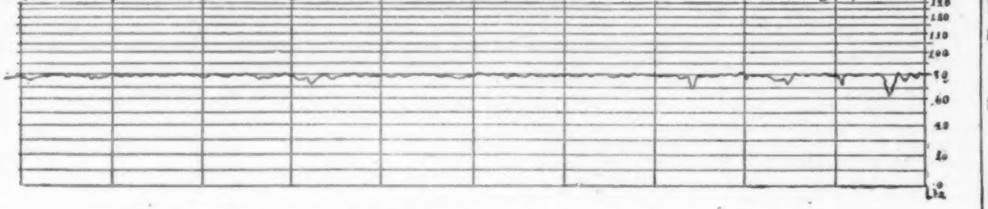


FIG. 7.—GAS ANALYSIS.

equal to the volume of the O which combined to form it, and 52 per cent. of free O. The volume of O in these two is, therefore, $= 12 + 5·2 = 17·2$ per cent. Now, assuming that the atmospheric air is composed of 4 parts of N and 1 part of O, by volume, we see that to correspond to this 17·2 per cent. of O we should have $17·2 \times 4 = 68·8$ per cent. N; but after absorbing the 17·2 per cent. of CO_2 and O, there remains $100 - 17·2 = 82·8$ per cent. Taking 68·8 per cent. from 82·8 per cent., we have 14 per cent. which must be composed of N and CO. Since the volume of CO equal to twice the volume of the combined O, we shall have the volume of $O = \frac{CO}{2}$ and since there is four times as much N as O, the $N = \frac{4\ CO}{2} = 2\ CO$. Therefore, we see that of this 14 per cent., 1 part is CO and 2 parts are N. $\therefore\ CO = \frac{14}{3} = 4·6+$, and $N = 4·6 \times 2 = 9·3+$, which being added to the 68·8 per cent. N, which corresponds



AUTOGRAPHIC RECORD OF STEAM PRESSURE DURING THE TRIAL, FROM EDSON GAGE

MEAN PRESSURE AS SHOWN ON THE DIAGRAM 78.4 LBS. PER SQ. IN.

MEAN PRESSURE CORRECTED . . . . 85.4 " " "

FIG. 8

to the free O, and that of the CO_2 = 78·13 per cent. To reduce per cent. by volume to per cent. by weight, we use the following constants:

Weight of	1 liter of		CO_2,	1·9774	grammes.
"	"	1	" "	O	1·43	"
"	"	1	" "	CO	1·254	"
"	"	1	" "	N	1·256	"

Multiplying the per cent. by the volume of each gas by the weight of a liter of that gas, we get certain values, a, a', a'', etc. Taking the sum of these = S, then the per cent. of weight would be $\frac{a}{s}$, $\frac{a'}{s}$, $\frac{a''}{s}$, etc.

To get the total O and the total C, the atomic weight of O = 16 and of C = 12 ∴ the amount of O in CO_2 = $\frac{2 \times 16}{12 + (2 \times 16)} = \frac{8}{11}$ and the amount of C = $\frac{12}{12 + (2 \times 16)} = \frac{12}{44} = \frac{3}{11}$.

In the same manner the amount of O in CO = $\frac{16}{12 + 16} = \frac{4}{7}$, and C = $\frac{3}{7}$.

Hence the total O = $\frac{8}{11} CO_2 + \frac{4}{7} CO + O$, and the total C = $\frac{3}{11} CO_2 + \frac{3}{7} CO$.

To get the ratio of air for dilution to that for combustion, we have $\frac{\text{Free O}}{\text{Combined O}} = \frac{O}{\frac{8}{11} CO_2 + \frac{4}{7} CO}$

To get air supplied per pound of carbon, we take the per cent. by weight of total O + per cent. by weight of N, and ÷ by the per cent. by weight of C.

(*To be continued.*)

TRIPLE THERMIC MOTOR.

DESCRIPTION, OPERATION AND RESULTS OF A SINGLE EXPANSION, NON-CONDENSING STEAM ENGINE, SUPPLEMENTED BY THE EVAPORATION OF THE BISULPHIDE OF CARBON AND EXPANSION OF ITS VAPOR, AT BRUSH ELECTRIC LIGHT COMPANY, CLEVELAND, OHIO.

By CHARLES H. HASWELL, M. Am. Soc. C. E.*

CONSTRUCTION.

First.—An ordinary horizontal and cylindrical fire tubular boiler.

Second.—A tubular generator in form of a cylinder boiler set horizontal, in which the material of vaporization, known as bisulphide of carbon (formula CS_2), is vaporized, having attached in the vapor space an ordinary perforated dry pipe.

All of which is inclosed in a shell having a diaphragm plate between the outer and inner shells at both sides and at one end, thus forming an upper and lower chamber around it. The opposite end is inclosed with a deep disk or bonnet, thus forming a communication between the lower and upper series of tubes, for the proper circulation of the steam with which the CS_2 is vaporized.

Third.—An ordinary horizontal non-condensing jacketed steam engine.

Fourth.—Conduit or vapor pipe, steam jacketed by being concentric with one extending from the generator to the cylinder of the engine, the jacket of the conduit communicating with the jacket of the cylinder, and from thence the condensed steam is led by a pipe to a steam trap communicating with the feed pump of the boiler.

Fifth.—An automatic regulator or pressure-reducing valve, for controlling the admission of steam to the shell surrounding the generator, operated by the pressured assigned to the generator, thus holding the vapor pressure uniform, by admitting more or less steam to the shell as the variation of the load on the engine may require.

Sixth.—An automatic reducing valve for controlling the pressure in the jacket around the vapor conduit and cylinder.

Seventh.—A heater having within it a coil pipe, through which the condensed CS_2 is forced back into the generator.

Eighth.—An ordinary surface condenser.

Ninth.—Three ordinary and small independent steam pumps, and a connection to a water main or centrifugal pump from which the water of condensation is obtained.

The generator, *i. e.*, the vessel in which the material of vaporization CS_2 is vaporized, and by which the expansive force is obtained wherewith to operate an engine for motive power, is charged with it to a little over one-half its capacity.

Steam, previously generated in a boiler or primary motor, is led by a pipe to and through the automatic regulating valve, where it is reduced in pressure and consequent temperature; thence to the generator through a perforated pipe between the shells below; thence flowing around the lower half of the generator shell; thence through the lower series of tubes; thence through the upper series; and thence between the shells above, thus circulating through and radiating heat to the entire surface of the generator, CS_2 taking up the latent heat and a portion of the sensible, thus the steam is condensed and gravitates to the bottom of the outer shell; from thence to the boiler feed pump (being one of the three referred to), with the condensation from the jacket of the conduit and cylinder, as delivered through the steam trap, and from thence returned to the boiler.

Steam is also admitted through the reducing or regulating valve, to and through the jacket of the conduit to the jacket of the cylinder, where it is restricted to a reduced pressure, and as it is at a temperature due to this pressure, it is at a temperature in excess of that surrounding the generator, thus imparting an increased temperature to the vapor and effectively superheating it in its course to and in the cylinder of the engine. The vapor generated from CS_2 in the manner described is delivered through the dry pipe to and through the conduit to the cylinder of the engine, and from the greater temperature surrounding the conduit and cylinder, the vapor is increased in temperature and consequent volume from its admission into the conduit and cylinder, until it reaches the point of cutting off, after which it continues to take up the surrounding heat, thereby supporting its expansive force until it has completed its function in the cylinder.

The exhaust vapor from the cylinder passes around a coiled tube in the heater referred to, thence to and through a surface condenser, from which it is drawn off by the second of the three pumps and delivered into an auxiliary condenser (through the tubes of which the circulating water is first introduced from the main, from thence through the tubes of the condenser, and thence discharged, as in a sewer), thus attaining perfect condensation of the vapor.

Any air drawn from the condenser by the air pump passes through a vessel termed the washer (which is partially filled with water) and thence to a waste pipe.

The liquid CS_2 gravitates from the auxiliary condenser to a reservoir. From thence it is drawn by the third of the three pumps and delivered through the coil in the heater (where it absorbs heat from the exhaust vapor on its passage to the condenser), thence to the generator, where it is again vaporized.

An entire plant designed for the development of the practicability and economy of this design of engine has lately been constructed for the Brush Electric Light Company, at Cleveland, Ohio, and on the 31st of May, 1887, a test of it was made under the direction of Mr. Isaac V. Holmes, representing the light company.

ELEMENTS OF THE PLANT.

An ordinary horizontal fire tubular boiler set in masonry having a grate surface of 16·5 square feet and a shell and tube surface of 225 square feet.

Combustion, natural draught. Coal, anthracite.

An ordinary jacketed non-condensing engine, single expansion, having a diameter of cylinder of 14 inches and a stroke of piston of 36 inches.

Generator, having a diameter of 54 inches, a length of 15·25 feet, and a steam heating surface of 1,550 square feet.

Surface condenser having tube surface of 1,000 square feet.

The operation of the engine was continued without interruption for a period of five hours, which, inasmuch as that period involved the cleaning of the fire in the furnace of the boiler, was held to afford full time for a test of the operation and the effects of the elements under investigation.

RESULTS.

Pressure, steam—boiler	75·8 pounds.
" " shell	15·3 "
" vapor—engine	76 "
" " mean, by indicator	31·35 "
Water evaporated	5·71 cubic feet.
Revolutions per minute	100
Vacuum	9·85 pounds.
Coal consumed	600 "
Horse power indicated	86·64

NOTE.—Pressures are given in pounds mercurial gauge and temperatures in degrees of Fahrenheit.

From which it appears that steam at a pressure of 75·8 pounds per square inch passed through the automatic regulating valve to the shell surrounding the generator at the reduced pressure of 15·3 pounds, due to a temperature of 250·4 degrees, produced a vapor in the generator of 76 pounds.

Sum of sensible and latent heat of steam at one atmosphere	1,178·1 degrees.
Sum of sensible and latent heat of CS_2	274·4 "
Latent heat of steam at one atmosphere	965·2 "
Latent heat of vapor of CS_2 at one atmosphere	156·4 "
Sum of sensible and latent heat of steam at 45 pounds (the pressure of the steam surrounding the vapor in the conduit)	1,206·6 "
Sum of sensible and latent heat of the exhaust steam at one atmosphere, as defined by the indicator cards	1,178·1 "

Hence, 1,206·6 minus 1,178·1 equals 28·5 degrees expended in the cylinder.

Sum of sensible and latent heat of CS_2 vapor at 76 pounds pressure, and superheated by steam at a temperature of 292·3 degrees (45 pounds) is	443 degrees.
Sum of sensible and latent heat of CS_2 at one atmosphere, that being the temperature of the exhaust, is	274·4 "

Hence, 443 minus 274·4 equals 168·6 degrees expended in the cylinder, and 168·6 divided by 28·5 equals 5·916.

Therefore, the relative theoretical value of the vapor of CS_2 as compared with that of steam is as 5·916 to 1; or, in other words, the heat admitted to the shell around the generator, additionally heated by the excess of that of the steam around the conduit and cylinder, will produce an elastic vapor in the cylinder of an engine 5·916 times greater than if steam alone was used.

Or, steam at 15·3 pounds pressure generates a vapor of 76 pounds pressure, which, when additionally superheated by being enveloped in steam at 45 pounds, its volume is increased and its pressure of 76 pounds is fully maintained at the cylinder of the engine.

In the test, the elements of which are here recorded, the consumption of coal per hour was 120 pounds.

Indicated horse power, 86·64.

Hence, 120 divided by 86·64 equals 1·385 pounds per indicated horse power per hour.

The volume of water at 50 degrees (the ordinary or mean temperature of condensing water) required to condense steam at the temperature of that of the vapor which passed through the heater (212 degrees, as determined by the indicator card) and deliver it to the boiler at the ordinary temperature of 100 degrees, is as 22·95 to 1, the volume evaporated.

The volume under like conditions for the condensation of the vapor is but as 3·67 to 1, to the volume evaporated.

Hence, when CS_2 is compared with steam, a less area of condensing surface and less volume of condensing water is required, both of which conditions involve an economy in the cost and endurance of an engine.

Reviewing then the elements submitted, it is presented, that by the use of the vapor of bisulphide of carbon in a vessel connected to an ordinary steam boiler and engine, condensing or non-condensing, an elastic vapor can be obtained greatly in excess both in pressure and volume of that of the steam that generated it, and, as an evident and infallible consequence, both increased power and economy of fuel are attained with less boiler surface and consequent wear.—*Trans. Amer. S. C. E.*

A GREAT AMERICAN ENTERPRISE.

FACILITY of intercommunication is a primary condition of civilization. One of the first of the duties of a government is to promote the construction of highways for the easy, swift, and secure movement of commerce. This is true of the streets of a town as well as of the highways of a nation. Good roads and convenient watercourses are positively essential to large trading operations; and the reduction of the cost of transportation by such means is a sure method of cutting down the prices of the necessaries of life. Because invention has reduced the cost of constructing railroads and of operating them, railroads are abundant; and because railroads built and operated at low cost are abundant, the prices of commodities have fallen so that they are lower than ever before, and therefore within the reach of a far larger number of people. Mechanical invention, and particularly the invention and improvement of the steam engine, is the one thing that gives to Americans a greater share of both necessaries and luxuries than any people have enjoyed since the world was created.

But water routes are necessarily even cheaper than railways, and by stimulating business and insuring fair competition they help the railways, and therefore, even in this age of cheap railroad transportation, a government cannot do more wisely than to improve and enlarge the means of water communication between various parts of the country. This fact ought to be the inducement for American public opinion to demand of Congress the approval, and the gradual development, of a grand scheme of water communication for which our continent seems to be peculiarly adapted. There are two or three plans now being urged for connecting the great lakes with each other by direct routes and for connecting Lake Michigan with the Mississippi river. Of the former it may be said that a country like ours, bordering on all the great lakes, ought not to be dependent upon a country like Canada for the privilege of canal communication between those bodies of water. Wherever there is such a canal upon the Canadian side alone, it should be duplicated by the act of our government upon the American side; and not only that our commerce may be protected from discriminations against it, which are now said to be made, but that we may have our own protected channels for shipping in the not impossible event of a war with England. It is discreditable to American foresight and to American enterprise that England actually has control of some of the most important waterways between our own lakes.

But our purpose now is to invite attention to a matter of much larger concern belonging to this general question. If a canal should be constructed from the Illinois river to the Mississippi, it will be seen that, with the help of the Erie canal across New York State, our Atlantic coast would have clear water communication with the Mississippi river, and therefore with the Gulf, and all within our own territory. Now, let us push this principle a good deal farther. All along the Atlantic coast nature has placed an interior and generally well sheltered water route, which seems to have been devised for the distinct purpose of exciting the ingenuity and enterprise of man to make it complete. Suppose a ship canal, as is proposed, shall be cut across Cape Cod. Then boats may come from Boston, on an inside route, through Long Island Sound to New York harbor. Thence a canal already runs to the Delaware river. From the Delaware there is an existing short canal across to Chesapeake Bay, which offers two hundred miles of sheltered navigation. From Norfolk, south of the bay, starts the Dismal Swamp canal, giving access to Albemarle Sound and to the long stretch of sounds lying inside the coast line of North

* Read at the annual convention, July 1, 1887.

and even South Carolina. Thence southward there are low lands, intersected by streams and other bodies of water practicable for a canal, until Savannah is reached; and from Savannah an admirable natural water route, on interior lines, is in existence and now in actual use clear down to Florida. Here is, we may say, the raw material for an unbroken and thoroughly safe inside water route from Cape Cod to Florida. With Cape Cod pierced, the Delaware and Hudson, the Delaware and Chesapeake, and the Dismal Swamp canals enlarged, as they stand, this entire route could be made navigable for vessels of considerable size clear to Charleston. The extension of such a route to Savannah offers no serious difficulties, though the cost might be large. From Savannah to Florida the way is open. Then the long projected ship canal across Florida would give swift access to the Gulf, and so to the Mississippi. Thus we should have a complete circuit of all that part of the country lying between that river and the Atlantic coast, and it would be possible for a boat to start from Chicago, go down to the Gulf and return up the coast to New York and thence to Chicago, without once showing its keel. If, now, the ship canal across the isthmus of Nicaragua should be completed, as seems likely, then the Pacific coast would be brought within reach of the commerce upon this system of waterways.

What would be the consequences to our domestic trade from the full realization of this great scheme, we leave to the reader to conceive. The imagination may deal with it without danger of exaggerating its value and its importance. The enterprise, in its dimensions and its consequences, would be worthy of the American nation; and more than that, it would be a magnificent attempt to utilize the noble opportunities given us by nature in preparing this country for our race. But it would serve another purpose than that of commerce. In the event of war with a foreign country, we should have a safe inside route which would enable our people to continue uninterrupted communication with each other, to move troops and supplies and to enable ships of war to pass from point to point with celerity and secrecy. Perhaps the undertaking is too vast for speedy completion. Perhaps it will not be seriously attempted during the life of any now living adult American; but that it will one day be a realized fact we are confident. Manifest destiny never more clearly indicated an occurrence for the future.—*Textile Record.*

THE CRANK'S STORY.

I WAS never anything but a crank, and although the world is not yet ready to do without me, I never had credit for all the help I have given it, one reason being that no two persons ever agreed as to how much I did help. Because, although I was most willing to work, I was never two seconds at a time in the same mind, and if I did come round to the same point pretty often, I did not stay there long enough for my friends to agree as to just what I was doing.

I was so uncertain in my movements that some gave

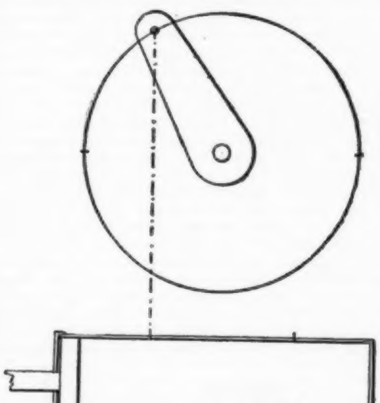


FIG. 1.

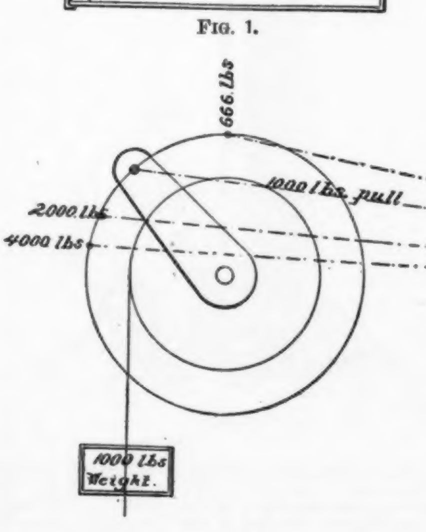


FIG. 2.

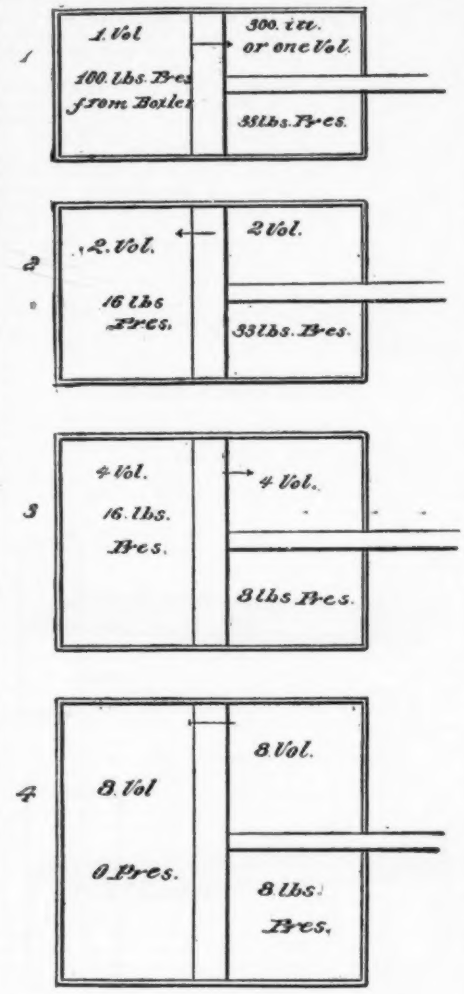
me up and tried to get around without me. But they generally came back and asked my help again.

I am of a very old family, although I did not set up a family name until a century or so ago, when somebody tried to tie me to a steam engine with a patent, which so disgusted my friend Watt that he sought help from a sun and planet. But, dear me, I turned a potter's wheel or pulled water out of a well ages before.

Of late years, by going into partnership with steam, we jointly do more work than all the rest of the world put together.

I suppose steam, being younger and more pushing than I am, is the reason he gets all the credit for what *we* jointly do.

Time was not long ago when it took me and steam and 10 lb. of coal to get a horse power per hour. Latterly I and steam have succeeded in getting a horse power per hour out of less than 2 lb. of coal. I propose to



show where I think my help came in, and will try to explain on a line of general averages, leaving out fractions, and will argue my case by comparison of leverages.

ARGUMENT.

There are those who claim that steam can be expanded in a single cylinder with the same good results as it can be in three or four cylinders. But as experience shows to the contrary, and as a single cylinder engine with one crank and a four cylinder engine with four cranks, both using the same weight of steam, and both supplied from the same boiler, show different results, it looks as if the cranks had something to do with it. In the following diagrams, Fig. 1 shows a crank supposed to be 6 inches throw, beneath which is a cylinder in which the piston moves back and forth 12 inches each way, to suit the crank pin; while the piston travels 2 feet, the crank pin travels 3 feet.

Fig. 2 shows a crank pin advanced one third of its travel from one dead center to the other.

In about this position a 1,000 lb. pull on the piston by the steam will balance a 1,000 lb. weight hung on a pulley whose circumference is equal to the two strokes of the engine—in other words, a pulley on whose rim a belt would travel as many feet in a given time as the piston did. This I term the par line. It is the line where the leverage of the crank is equal to the power of the engine.

The diagram also shows that about ½ the pull of the piston is expended on ⅓ the travel of the crank pin, and this when the power of the crank pin is above par. The crank pin has to pull the same load, the ⅔ of its travel below par as it has when it is above par, and only has half the steam to do ⅔ of the work, and that half when it has the least power to help.

Let us compare a single cylinder engine used expansively with one of four cylinders using the same weight of steam in each and getting the same expansion. Say the four cylinders have piston areas of 50 inches, 100 inches, 200 inches, and 400 inches.

We arrange the cranks alternately opposite each other (and use flywheel in both engines). Thus in both engines when the crank pin is at its best, or at right angles, the pistons will all be about in the center of the cylinders, as in diagram No. 3.

As cylinder No. 4 with its 400 inches has eight times the volume of No. 1 with its 50, we get eight expansions, or sixteen if we cut off No. 1 at half stroke, which we propose to do; and, starting from the boiler with 300 inches of steam at 100 lb. pressure, we will follow it through its different stages in each cylinder and see the result, and refer to diagram No. 3.

In the back end of No. 1 the steam is 100 lb. on the 50 inches, and is one volume. In the second stage the same inches of steam fill half No. 1 and half No. 2, equal to three volumes and 33 lb. pressure, which is back on No. 1 and forward on the 100 inches of No. 2.

So the net power from No. 1 is 100 less 33 = 66 on 50 inches = 3,300 lb. push on crank.

The same steam in next stage fills half of No. 2 and half of No. 3 with six volumes and 16 lb. pressure. This is sixteen back on the 100 inches of No. 2 and sixteen forward on the 200 inches of No. 3, giving a pull to the good from No. 2 of 1,600 lb.

The same steam then goes into the half of No. 3 and half of No. 4, having twelve volumes and 8 lb. pressure.

This is 8 lb. back on the 200 inches of No. 3, which has sixteen forward on it, so there is 8 on 200 = 1,600 lb. to the good from No. 3.

As there is no back pressure on No. 4, it has the good of the whole 8 lb. on the 400 inches = 3,200 lb.

This is a total force above back pressure of 3,300 + 1,600 + 1,600 + 3,200 = 9,700 applied to the four cranks when they are at their best point of leverage.

To get the same expansions in a single cylinder, it must have 400 inches of piston area same as No. 4 in the multicylinder, and the steam must be cut off at $\frac{1}{16}$ of the stroke. This would be when the piston has advanced ¾ of an inch.

Put in the 300 inches and cut off at ¾ of an inch. Then, at one and a half inches it would be 50 lb., at three inches advance it is 25 lb., at six inches advance it is 12½ lb., and the crank is at best point.

This 12½ lb. on the 400 inches of piston is but 5,000 lb. of push on the crank at right angles against the 9,700 lb. of push on the cranks in same position in the other engine.

Such multicylinder engines are not generally made with cranks opposite each other and with flywheels, but it is the fair way to compare the two systems. All questions of varying temperature and mechanical arrangements of valves are also in favor of the four or more cylinder engines, for 150 lb. boiler pressure and more cylinders would give better results still.

G. H. EDWARDS, C.E.

A STEAM LOGGER.

THERE may be seen at the camp of Shields & Wilson, jobbers for the Sawer-Goodman Company, located in Northern Michigan, on a little lake that is the source of the Escanaba River, a steam logger or snow locomotive, the most unique machine ever invented for logging purposes, and one that appears destined to work a revolution in certain directions. Two and a half or three years ago, George T. Glover, an old Saginaw Valley logger, brought to the *Lumberman* office for inspection the plans of a machine that, in his opinion, would be a great thing—not only on ice, but on snow. The *Lumberman* confesses that it had no great faith in it. Mention was made of the invention in these columns, and the result was numerous inquiries regarding it. The giant machine, however, is not anything like an exact materialization of the plans exhibited to the *Lumberman* three years ago. It is a creation of evolution and of the woods. Mr. Glover, to start with, had the principle in his head all right, but to apply it successfully to machinery has been a long and expensive job. The logger is the result of a series of experiments. The original machinery was entirely discarded. When a weak point was discovered it was strengthened, and when it is known that nearly every change necessitated sending to Chicago for new parts, it will be understood that the process of construction was tedious. But genius, grit and money conquered, and the outcome is a machine weighing 12 tons, that can be driven by steam on a snow road, and draw, it is asserted by some, as many as 30,000 or 40,000 feet of logs—a statement the *Lumberman* is aware will be considered by many as one of the most wonderful pertaining to the lumber business ever put on paper.

The mechanism of the logger is simple, and in some respects very ingenious. Nearly over the center of the hind sled sits the 10 × 12 double upright engine, which is 120 horse power, geared ten to one, thus increasing it to 1,200. Midway between the two sleds the boiler is located. This is of steel, 5½ ft. in diameter, 7½ ft. high, with 320 two-inch submerged flues, and gauged to a pressure of 150 pounds. The steam pipes have swivel joints. There is a steam siphon for filling the water tank, and an apparatus for heating the water before it enters the boiler. Either wood or coal may be used as fuel. There are four wheels on the driving axle, 4 ft. in diameter, weighing three tons. Each wheel is a foot wide, and on its face there are 17 teeth, 9 in. apart.

The angle of these teeth is 3 in.; they are held in place by bolts and nuts; therefore if less traction

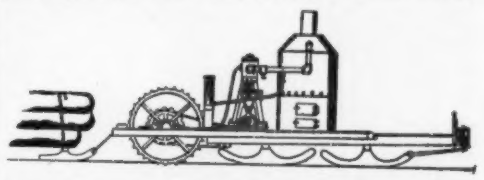


DIAGRAM IN OUTLINE OF THE STEAM LOGGER.—(Reduced from Working Drawings.)

power is required, teeth of a shorter angle can be affixed. The axle of the drivers is of steel, 6 in. in diameter, 7 ft. long and weighs a half ton. If desired two of the wheels may be removed, and the remaining two placed on the axle in any position required. The steering gear is simply a wheel in front, which places the tongue of the forward sled in any desired position by means of a link belt chain running over the wheel, over pulleys attached to either side of the frame, and made fast to the sled tongue. The drive chain, between the engine and the drivers, is made of 1¼ in. Ulster iron, and weighs 18 pounds to the foot.

The logger is 28 ft. long, and of course a rigid machine of that size could not be driven over other than a level road. To overcome this difficulty, the drivers and the engine are supported by separate frames, the pivot point of their connection being about the middle of the front sled. By unfastening the drive chain and removing the connecting bolts the two frames are disconnected, and the horse (the engine), as it were, may be taken from between what one might imagine to be the thills—the long timbers extending forward from the drivers. The bolts fastening the two frames together slide in slots; in the ends of the thills there are embedded powerful springs, and to compress these springs to a proper tension are jack screws, which are made fast to the engine frame. It will thus be seen that the springs act as a cushion, and that the logger

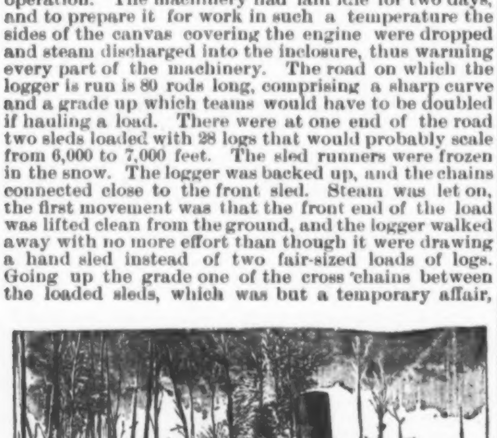
will adapt itself to the unevenness of a road. To further assist in this purpose there is a steam piston, the upright box of which may be seen in the engraving over and immediately in front of the wheels. The piston box is fastened to the frame of the wheels, and when necessary, by the use of the piston the rear sled, bearing the weight of the engine and part of the boiler, can be lifted clean from the ground, thereby doing away with but two points of contact, the front sled and the drivers, and at the same time throwing additional weight upon the latter.

All this mechanism of itself, however, would not make a successful log-hauling machine. That much accomplished, the point is yet to be gained that has been declared impossible by hundreds of lumbermen as well as mechanics, namely, sufficient traction and roadmaking power of the driving wheels. This great obstacle—so

THE STEAM LOGGER AT WORK.
(From an Instantaneous Photograph.)

considered by persons who have not seen the logger—is overcome by turning the exhaust steam on the driving wheels. The wheels are decked, and around the edges, under the frame, are heavy rubber curtains which nearly reach to the road surface. The wheels literally work in a steam box, are heated by steam, and when they pass over snow it is damped and compressed, and in cold weather immediately converted into solid ice. By chopping in the road over which the logger has probably run 100 times, the fact was disclosed that the ice was from 6 to 9 in. thick. The chain running from the loads may be hitched to the frame directly in the rear and on a line with the axle of the drivers, or, if a very heavy load is to be hauled, a foot and a half higher. In the latter case it will be readily understood that the frame extending three feet back of the axle of the drive wheels acts as a lever, and that the harder the logger pulls, the greater the weight on the wheels, and consequently the greater the traction.

It was during a decidedly "cold snap" when the representative of the *Lumberman* saw the logger in operation. The machinery had lain idle for two days, and to prepare it for work in such a temperature the sides of the canvas covering the engine were dropped and steam discharged into the inclosure, thus warming every part of the machinery. The road on which the logger is run is 80 rods long, comprising a sharp curve and a grade up which teams would have to be doubled if hauling a load. There were at one end of the road two sleds loaded with 28 logs that would probably scale from 6,000 to 7,000 feet. The sled runners were frozen in the snow. The logger was backed up, and the chains connected close to the front sled. Steam was let on, the first movement was that the front end of the load was lifted clean from the ground, and the logger walked away with no more effort than though it were drawing a hand sled instead of two fair-sized loads of logs. Going up the grade one of the cross chains between the loaded sleds, which was but a temporary affair,



SIDE VIEW OF THE STEAM LOGGER.
(From an Instantaneous Photograph.)

gave way, and the rear sled plowed into the snow bank farther than a dozen horses could have drawn it. The locomotive did not halt. It gave an extra puff; the chain attaching it to the logs snapped as though it were twine, and the logger marched on up the grade, seemingly rejoicing that what it might consider a base effort to stall it was frustrated. This accident showed that the power of the machine is not only ample, but really great.

The speed of the logger is about five miles an hour. When not loaded it is necessary for a man to run sharply to keep up with it. A certain amount of snow seems to impede it but slightly, if any. An old road that led to a skidway leaves the main road and strikes into it again after going twelve or fifteen rods. On this road there was about a foot of newly fallen snow. The bottom of the road was not even. As a test it was decided to run the logger around this curve. The *Lumberman* representative saw a stick protruding through the snow, and suggested that it be removed.

"If you think we require a dude road to run on I will show you to the contrary," said Mr. Glover, and suiting the action to the word, he picked up some big sticks from a pile of four-foot wood and tossed them into the snow. The logger was driven over the road and on to its old beaten path without a halt, leaving the prints of its teeth two inches deep or more in the cord wood. It is plain that the locomotive can wade through at least a foot of snow without being materially bothered. It was an unfair test to put the machine to, but it came out victorious.

The logger, when not in motion, has a cumbersome appearance. At a little distance it looks not unlike a tug that a flood has landed high and dry. Before seeing it move one would not imagine that it could be handled advantageously. In this respect it is a big surprise. It is completely under the control of its operators. It can be turned within three minutes, with probably time to spare, and on space not greatly exceeding 25 × 50 feet. A driver of a six horse team, on a given area, would have to hustle if he succeeded in getting his horses head to in less time than the logger can be turned. It runs backward as readily as forward. Three men are necessary in operating it—an engineer, a fireman and a steersman. Under favorable conditions the amount of logs it would bank in a day would astonish the natives.—*N. W. Lumberman.*

METALLIC BEDSTEADS.

WE give a few illustrations of metallic beds of simple construction. Fig. 1 an ordinary bedstead of metal. Fig. 2 the same with springs and casters. Fig. 3 bedstead composed of same and convex spring bottom. Fig. 4 a combined bed, mattress, and writing desk. Fig. 5 the same turned up for use. The front legs and cross support are removed and form a bench or seat.

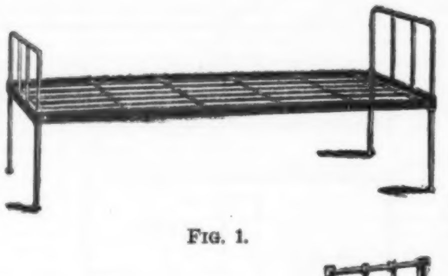


FIG. 1.

FIG. 2.

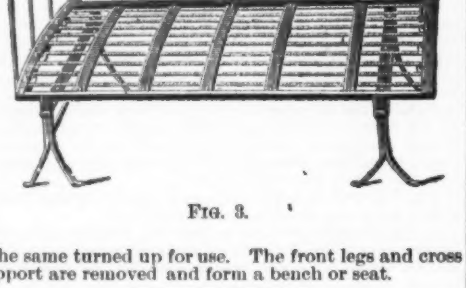


FIG. 3.

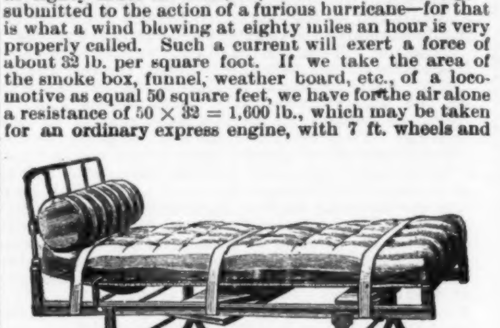


FIG. 4.

FIG. 5.

HOW FAST CAN A LOCOMOTIVE RUN?

POPULAR opinion concerning the maximum speed at which a locomotive can run is, even among engineers, very vague. The subject is little understood, and rash assertions are sometimes made in consequence. We have ourselves heard it asserted by those who ought to know better, that a speed of over 100 miles an hour could easily be reached with a light engine; and recently we illustrated a French engine intended to run regularly at eighty miles an hour. Now, as a matter of fact, there is no properly recorded instance of an engine attaining a greater velocity than eighty miles an hour, which was reached by one of Mr. Pearson's broad-gauge tank engines with 9 ft. drivers on the Bristol and Exeter Railway. The engine was run light, and driven down an incline of one in eighty-nine; and a speed of seventy-eight miles an hour was attained under precisely similar conditions with one coach attached. A very valuable report on the railways of Great Britain has been prepared by Mr. Charles Rous Marten for the use of the Minister for Public Works, New Zealand, and in this we find a good deal of information on the subject of railway speed put into a convenient form. Mr. Marten fully confirms the view we have taken that speeds of more than eighty miles an hour are mythical. At first sight there does not appear to be any adequate reason why this should be the case. Given plenty of steam, a good road, and a falling gradient, and an engine which, with a heavy train behind it, will make seventy-two miles an hour, apparently ought, when running without a load, to attain a much higher velocity. In this case, however, conclusions drawn from theory are wrong, and, as we have said, a speed of eighty miles an hour seems to be the utmost that it is possible to attain under any circumstances.

So little is known about train resistances at extreme speeds that it is not easy to say what is the amount of the retarding force caused by the motion of the engine regarded simply as a vehicle. There is, however, reason to think that this, whatever it may be, bears but a small proportion to the whole resistance due to other causes than axle friction and the rolling of the wheels on the rails. The resistance of the air is very great. It is the same thing whether the engine runs through still air at eighty miles an hour, or, when itself standing, is submitted to the action of a furious hurricane—for that is what a wind blowing at eighty miles an hour is very properly called. Such a current will exert a force of about 32 lb. per square foot. If we take the area of the smoke box, funnel, weather board, etc., of a locomotive as equal 50 square feet, we have for the air alone a resistance of 50 × 32 = 1,600 lb., which may be taken for an ordinary express engine, with 7 ft. wheels and 18 in. cylinders, as equivalent to about 16 lb. per square inch average effective cylinder pressure alone. But this is only one of the retarding influences with which we have to deal. Another of very much greater proportion is the back pressure in the cylinders. The steam cannot be got out fast enough through any available port. A 7 ft. wheel makes 240 revolutions per mile, and when running at eighty miles an hour 320 per minute. Thus there must be from each cylinder 640 exhausts per minute, or over 10 per second, or for the two cylinders 21 per second. The cylinder full of steam is therefore allowed only the tenth part of a second to get out; and it is not remarkable that the back pressure is something very considerable. At the time of the celebrated brake trials at Trent, the loads were in all cases thirteen coaches, and very different types of engines were employed to pull them. Each engine had a run of three miles on a level allowed it in which to get up speed; but during the whole time the trials lasted, a velocity of sixty miles an hour was never attained. It was found that most of the drivers worked their engines near the middle notch while on the three miles to save steam. The moment they got on the trial ground they put the lever forward a couple of notches, intending to get more speed; but the result was invariably to choke the engine with steam and reduce the speed. Unquestionably the great obstacle in the way of attaining a higher velocity than eighty miles an hour lies in the difficulty of getting rid of the steam; and this is the reason why compound engines do not readily attain very great velocities, because for a given power they have larger piston areas than have non-compound locomotives. There are, however, other retarding forces at work. Much power must, no doubt, be lost in imparting violent motions to masses of metal which can make no return when coming to rest. The swinging of the engine, the excessive vibration of all its parts, and the jar and concussion, all operate to the same end, and tend to keep down speed.

There are some very curious facts connected with railway resistances yet to be considered; one is the extraordinary retarding influence of very moderate rising gradients. The performance of the Flying Dutchman broad gauge train between London and Swindon is celebrated all over the world. Mr. Marten tells something about this train not generally known. The up train always keeps time; it has been known to be several minutes too soon at Paddington. But it is all the engines can do to get to Swindon in time. There is a long gradient of 1 in 1,320 for fifty miles, and 1 in 700 for the rest of the distance against the down trains, and in favor of the up trains, and this makes all the difference. Now, a gradient of 1 in 1,320 only represents a resistance of 1·7 lb. per ton, or for the run both ways 3·4 lb. per ton in favor of the up journey. The weight of the train is about 130 tons—say the total weight, including engine and tender, is 200 tons; we thus see that a resistance of 680 lb. against the engine makes all the difference. This is surely remarkable, as the tractive force of the engine is 81 lb. per pound of effective cylinder pressure. It follows that the average effective cylinder pressure on the up run will be less than that on the down run by about 8·4 lb., and this suffices to render the one run a difficult

performance, while the other is accomplished with ease. If it was only possible to reduce the average back pressure by 8·4 lb., it will be seen that an immense advantage would be gained. The great difficulty lies in providing larger exhaust passages; but it must not be forgotten that as these are also steam passages for a portion of their length, an augmentation of port space might entail a loss. However, it is worth while when designing engines intended to attain great speeds to bear this in mind.

It appears to be beyond question that coupling an engine tends to keep down speed. On this point we have, however, nothing in the way of proof to offer, save the fact that the fastest trains in the world are run on the Great Northern Railway with single outside cylinder engines. One of these engines has taken a passenger train from London to Peterborough, 76¼ miles, in 78 minutes, and to Grantham, 105½ miles, in 112½ minutes, and some fifty miles of this is up hill. From Hitchin to Peterborough, 44½ miles, has been run in 47¾ minutes, with 175 tons. Another engine has taken a load of 160 tons, 61¼ miles in an hour. Such performances as these are unrivaled, although very nearly equaled by the Midland, which, however, runs heavier trains at less speed. The line, too, is so hilly that it is difficult to make comparisons. The curious fact remains after all has been said, that in running down inclines at maximum speeds the weight of the train seems to have little or no effect on the speed. It would appear, indeed, as though the train on a steep bank rather helps the engine than retards it, because the train has no internal resistances which can be compared in magnitude with those to which the engine is subjected.—*The Engineer, London.*

THE ARGENTINE REPUBLIC AS A WHEAT FIELD.

IT seems certain that from henceforth the milling trade of Great Britain will receive more and more important supplies of grain from this country. But a few years ago La Plata wheat was a rarity on Mark Lane Corn Exchange, and it is within our recollection that one of the largest wheat factors of the metropolis, on receiving an inquiry for it, marked, "That's a good kind of wheat, but I am afraid we have neglected it. Now and again a small lot reaches me, but, generally speaking, it does not find its way to this market." But that is all changed now. Excellent samples of La Plata wheat are now to be seen in every direction as one passes along the stands on Mark Lane Market, and it is but a few weeks ago that a cargo amounting to six thousand quarters was unshipped at Liverpool. Some of our best milling authorities speak highly of this Argentine wheat, and compare it to winter, with which kind of grain it has undoubtedly much in common. If it does not possess the great strength of the hard spring wheats of the Western States and of Manitoba, it has a peculiar mellowness which seems to promise well for the flavor of the flour which it may be made to yield. But it would be a great mistake to imagine that all La Plata wheat is the same in character, or even necessarily of the soft variety. A miller owning one of the most important mills in the republic assured us that the arable lands of La Plata yielded both hard and soft wheats, and that both were of good quality. It must be borne in mind, moreover, that this country already boasts a milling industry which is not only capable of meeting home wants, but also manages to compete not unsuccessfully with Austro-Hungarian and United States millers on the neutral ground of Brazil, and it is likely enough that the harder wheats are at present bought up by the Argentine millers. As the culture of wheat extends, and the exportable surplus increases in volume, it may be reasonably expected that we shall see greater varieties of Argentine wheat in Great Britain. And then our millers may be able to handle the hard grain of the republic. One fact stands out clearly enough. The land known as the Argentine Republic is not only one of the most extensive and fertile of South American countries, but its history during these later years marks it out as one of the most progressive of South American communities. In this favored land revolutions and internecine wars, those scourges of the southerly and central portions of the American continent, have not been heard of for years. But the government is not merely settled and orderly—which negative good qualities would in themselves be no slight guarantee for the industrial progress of such a country—it has of late years given active proofs of being progressive in the best sense of that much abused word. It has promoted, and is still promoting by every means in its power, the diffusion of education, the reclamation of the soil, and in general all industrial enterprises likely to benefit the country. Although the president, who is elected for a term of six years, is a Catholic, as are most if not all the officials, yet there is no whisper of religious intolerance, and Jews as well as Protestants are in free and undisturbed enjoyment of Argentine citizenship. In short, except for the language, which is Spanish, there seems nothing in this republic to recall the typical South American state, with which neither industry nor commerce can have much cousinship.

The territory of the republic extends along the shores of the South Atlantic Ocean as far as the Strait of Magellan. Its extreme length is about 2,300 miles, while its average breadth is 500 miles, so that its total area exceeds 1,200,000 square miles, or 120,000 square leagues. A more definite idea of the immensity of this area will be gained from its comparison with countries nearer home. Thus it has been estimated that the areas of the United Kingdom, France, Germany, Austria, Hungary, Italy, Spain, Portugal, Belgium, Holland, and Greece would, all put together, not exceed the space occupied by this country. The land falls into four great natural divisions: the Andine region, which comprises seven great provinces, covering an area of 296,000 square miles; the Pampas, which almost correspond to the prairies of the Western States, and, stretching from Pilcomayo in the north to the Negro River in the south, contain 520,000 square miles and include six great provinces; Patagonia, with an area of 330,000 square miles (a great portion of which is said to be desert); and the Argentine Mesopotamia, an area of 80,000 square miles between the Parana and Uruguay. The watershed drained by the River La Plata covers 880,000 square miles, and is said to be the largest in the world, with the exception of the basin of the Amazon. Not the least advantage of the noble river system of the republic is the great facility afforded thereby to the cheap conveyance of produce. Wheat, for instance, is a heavy and bulky material, which can be best conveyed by water, when such means of transport is available. Not that this country is lacking in railway communication. On the contrary, the railroads of the Argentine Republic are a standing monument to the enterprise of her government and people. Already they cover about 4,635 miles, and several extensions are in course of execution. Buenos Ayres is the center of the railway system, and from this city of 400,000 inhabitants there radiate five main lines, which run north, south, and west, serving the provinces of Buenos Ayres, Santa Fe, Cordoba, Rioja, Mendoza, Catamarca, Tucuman, and Santiago del Estero. In the provinces of Entre Rios and Corrientes railway communication is less advanced, though even there some important lines have been made, and others are in course of construction. It is noteworthy that from Buenos Ayres a railway has been pushed across the continent to the confines of Chili, and that by this line the great center of Argentine commerce will very shortly be placed in direct communication with Valparaiso. In the meantime another line is being taken southward from Buenos Ayres, and will, when completed, place that city in communication with Talcahuano and Concepcion, which lie on the Pacific coast some distance south of Valparaiso, and are both in the heart of the coal district of Chili. The port of Bahia Blanca, which lies in a sheltered bay south of Buenos Ayres, will also be brought into this system, so that the near future will see the continent of South America traversed from ocean to ocean by at least two lines of railway. As a port Buenos Ayres has grave disadvantages, from the fact that it possesses at present no docks or harbor in which large vessels can lie, and ships have now to anchor ten miles or so outside of the city to avoid running aground on the sand and mud which the River La Plata washes down in front of Buenos Ayres. To remedy this the construction of a large harbor is to be undertaken, and it is hoped that this enterprise, when complete, will make the city the great port of the South Atlantic Ocean. Nor should it be left out of sight that a railroad runs north from Buenos Ayres to Tucuman, whence it is being continued to Jujuy, with Bolivia, that rich gold and silver producing land, as an ultimate objective. Generally speaking, the railways in the Argentine Republic complement its river system—the La Plata, with its mighty affluents the Paraguay and Parana—as highways of commerce. It is also to be remarked that the railroads which pass through the chief centers of agriculture (the provinces of Buenos Ayres and Santa Fe) are well provided with branch lines, so that every facility is afforded to the farmer whose lands lie some distance from the river. The population of this immense territory is as yet certainly small, as it does not exceed four millions at the outside, or about the population of our Australian colonies; but then it must be remembered that it is spread over a relatively small portion of the total area, from which it follows that its industrial capacity will be greater than appears on a cursory view. The native population is estimated at 3,287,000, while the foreign immigrants are reckoned as over 650,000; of these 40,000 being English and the balance Italians, French, and Germans. It is certain that the Italian is the largest foreign element in the republic, as immigrants from Italy have during the past few years formed seven-tenths of the foreign settlers; there are said to be 150,000 French, and a considerable sprinkling of Germans is also to be found, especially in the towns. The Argentine Republic seems marked out by its physical conditions as a pastoral land. It possesses more sheep than any other country, and in horned cattle and horse stock comes next to the United States and Russia, so that it is not surprising that its chief industry should still be breeding. But agriculture has during the past decade come to be a formidable rival to the pastoral industry, and the total area of tilled land in the republic is now believed to be as much as 6,000,000 acres, half of which are under wheat. Under these circumstances it was to be anticipated that the country should be able to export year by year an increasing amount of grain. The following table will show what have been its dealings with the United Kingdom in wheat and other kinds of grain since it first began to dispose of an exportable surplus:

GRAIN IMPORTS FROM ARGENTINE REPUBLIC INTO UNITED KINGDOM.

Quantity.	1875.	1876.	1877.	1878.	1879.	1880
Wheat.............cwt.	10	721	436	21,887	180,793	25,449
Other kinds of grain...	3,983	37,379	8,604	42,730	49,508	2,344
Estimated Value.	£	£	£	£	£	£
Wheat..................	6	334	262	13,592	86,936	13,815
Other kinds of grain...	1,387	11,397	2,862	12,179	12,906	833
Quantity.	1881.	1882.	1883.	1884.	1885.	1886.
Wheat.............cwt.	31	18	125,293	210,444	334,195	268,696
Other kinds of grain...	14,586	480,044	20,431	255,844	468,485	1,314,077
Estimated Value.	£	£	£	£	£	£
Wheat..................	15	12	60,052	87,324	120,215	94,648
Other kinds of grain...	4,586	184,112	7,155	72,231	120,267	290,891

The soil is eminently favorable for wheat raising, inasmuch as it is described by experts to have much affinity to some of the richest wheat lands of the world; it is said to closely resemble the earth of the Mississippi Valley and the black loam of South Russia. Its yield is variously estimated, but ten bushels to the acre appears to be a fair average return. In this connection it must be borne in mind that the Argentine wheat grower does not practice rotation of crops, and dispenses with manure, so that, under the circumstances, the yielding capacities of the land must be held very great. The accounts of last year's crop show a slight variation, but one reliable authority computes the wheat crop at rather more than two million qrs., which is a little below the yield of the previous year.

The provinces of Buenos Ayres and Santa Fe take the lead at present in wheat growing, but a considerable crop is raised in other provinces, and there seems to be no doubt that wheat culture will steadily advance with the progress of time. The "Colonies," as they are called, or emigrant communities cultivating large tracts of land, which form so prominent a feature in the industrial life of the republic, are said to have done much for agriculture and specially for wheat raising, and, happily, there is every likelihood of this movement gaining more and more ground.

Among the colonies is one which has a special interest for subjects of the United Kingdom, inasmuch as it is composed entirely of natives of the principality of Wales. This is the colony of Chubut, settled in the valley of Chubut, which extends from the mouth of the river of that name in Patagonia in a southern direction to 78 W. latitude. These colonists are all survivors or children of a party of 180 Welsh emigrants who settled in this spot in the year 1865, under the guidance of Mr. Lewis Jones. After years of suffering they attained to some measure of prosperity, and are now said to cultivate 16,610 acres of land, on which grow 210,000 bushels of grain. Of this crop 97 per cent. is said to be wheat.

One feature of industrial life in this land we have here but lightly handled, namely, the milling industry. The Argentine Republic possesses, relatively to its population, a very flourishing milling industry (in 1884 the province of Santa Fe alone had 24 flour mills), and is able, as we have already seen, to export largely to the neighboring country of Brazil. It is scarcely to be apprehended, however, that the Argentine miller will every become a serious rival to his British congener, and for this reason, that he cannot ship his flour to the United Kingdom without passing it over the line and taking the risk of its loss through the fermentation which the passage of that latitude so frequently exercises on flour and similar substances. So far as can be seen, it is as a great granary that the Argentine Republic will affect the British milling trade, and such a granary can only be hailed as a boon.—*The Miller.*

AN END OF THE ALKALI WASTE.

AN ancient and most serious nuisance seems at last destined to extinction. Many of our readers are familiar with, and not a few have suffered from, the foul emanations emitted from the vast piles of alkali waste, or vat waste, as it is often called, which surround some of the great alkali works of the country. The nuisance dates from 1823, when the ingenious process of Leblanc, the French apothecary who made so many millionaires, and who died himself in a French workhouse, was first adopted in England. This process, which is still extensively used, although of late it has suffered from a formidable rivalry, consists in the conversion, by three distinct methods, of common salt into carbonate of soda.

The alkali manufacture, as a whole, comprises far more than this, for sulphate of soda, hydrochloric acid, bleaching powder, caustic soda, bicarbonate of soda, chlorate of potash, and other chemicals are also produced in the cycle of operations. Each contributes to the profits, and each is the starting point in one or more important industries. Common salt is the first raw material, and the magnitude of the trade may be inferred from the fact that in 1887 no less than 731,199 tons were decomposed by the Leblanc and its modern rival the ammonia-soda process. Of late years the Leblanc makers have held their own with difficulty against the firm of Brunner, Mond & Co., of Northwich, who have in England a monopoly of the ammonia-soda process.

The nuisance to which we now refer arises only in the Leblanc method, and it has long formed a serious part of the difficulties with which the older manufacturers have had to deal. The nature of the nuisance is as follows. Salt is converted into sulphate of soda by sulphuric acid. The sulphuric acid was formerly made from Sicilian sulphur, but pyrites ore, being cheaper, has long been substituted for it. By ignition with chalk and coal, the sulphate of soda is transformed into a mass called "black ash," which is a mixture of carbonate of soda, sulphide of calcium, and impurities. The carbonate of soda is washed out and evaporated, while the residue is thrown away. It is this residue which is known by the name of "alkali waste." It contains almost the whole of the sulphur of the original sulphuric acid in the form of sulphide of calcium. Now sulphide of calcium is easily decomposed by acids, with evolution of sulphureted hydrogen; and, as the rain which falls in manufacturing towns is strongly acid, the drainage from the heaps of waste to which we have referred pollutes air and water with the odor of rotten eggs. Those who have visited St. Helens, in Lancashire, and wandered by the mountains of alkali waste which cumber its plain, and by the unfortunate Sankey brook which flows among them, can realize the nuisance for which the alkali makers are responsible. The water of the Sankey looks like pea soup and smells like a cesspool.

Many attempts have been made during the last fifty years to recover the sulphur from alkali waste, and so yield a new profit to the manufacturer, while annihilating a terrible nuisance. Mr. Alexander Chance, of the firm of Chance Brothers & Co., Birmingham, in a paper which he read to the London section of the Society of Chemical Industry on March 5, alluded to some of these attempts, those of the late Mr. Gossage, Mr. Mond, and Messrs. Schaffner and Helbig being among the most successful. But the main object of Mr. Chance's paper was to describe a system which he has adopted in his works, which not only avoids all risk of nuisance, but offers many commercial advantages. The first part of the new system consists essentially in treating the alkali waste with carbonic acid from the lime kiln. Lime is required for the manufacture of caustic soda, so carbonic acid is a by-product. The carbonic acid when passed into the waste is at first absorbed by the free lime. When this is saturated, the gas acts on the sulphide of calcium, which at first is converted into sulphydrate. During this stage of the working nitrogen only is evolved, and the special novelty of the Chance patent is the removal of this inert gas at periodical intervals. The further action of carbonic acid on the sulphydrate yields calcium sulphate, and a gas containing about 30 per cent. of sulphureted hydrogen and 70 per cent. of nitrogen.

The sulphureted hydrogen is now pure enough to burn, and the sulphurous acid thus formed can be converted directly into sulphuric acid in the ordinary manner. Messrs. Chance have made large quantities in this way, and the acid obtained is of excellent quality, and entirely free from arsenic. But a more profitable alternative exists, and has been introduced with the most satisfactory results in the Birmingham works.

Mr. C. F. Claus, whose method for purifying coal gas is now under trial on a large scale in the Belfast gas works, has invented a method of obtaining sulphur from sulphureted hydrogen which is as simple and inexpensive as it is efficient. This method, which is already in extensive use in chemical works where sulphureted hydrogen is evolved, consists in mixing the gas with air enough to oxidize the hydrogen, but not the sulphur, and then passing the mixture through what is known as the Claus kiln. This is merely a brick chamber with a false bottom, which contains a layer of oxide of iron, or some other suitable substance, which, reacting on the mixture of gases, causes the formation of sulphur and water without permanent alteration of the oxide. The necessary temperature is maintained by the heat of the reaction. The vapors which leave the kiln consist mainly of sulphur and steam with nitrogen. They pass into a receiving chamber, in the first part of which melted sulphur collects and can be drawn off into moulds, while a little further on flowers of sulphur of the finest quality are obtained.

The commercial importance of this system is easily understood. At present the whole of the sulphur of the sulphuric acid, amounting in England to about 100,000 tons a year, is thrown away. Now all this will be altered. The sulphur can be recovered at a slight expense, and with very little trouble. It may be converted into sulphuric acid, in which case very little pyrites will be wanted, or by the Claus process it can be obtained in an almost chemically pure state. Pyrites sulphur at present costs about £1 10*s*. per ton, whereas pure sulphur sells in the market at from £4 to £9 per ton. The alkali waste after the new treatment is perfectly innocuous. It may be thrown anywhere without the possibility of a nuisance arising from it. But doubtless it will be utilized either in the black ash process or in the manufacture of cement. Altogether, it is not surprising that so large and influential an audience should have assembled in Burlington House to hear Mr. Chance's paper. Every sanitarian, as well as every one interested in the commercial prosperity of the country, must wish success to the new enterprise.

HOW TO MAKE A SIMPLE ELECTRIC MOTOR.

By George M. Hopkins.

It is generally understood that an efficient electric motor cannot be made without the use of machinery and fine tools. It is also believed that the expense of patterns, castings, and materials of various kinds required in the construction of a good electric motor is considerable. The little motor shown in the engravings was devised and constructed with a view to assisting amateurs and beginners in electricity to make a motor which might be driven to advantage by a current derived from a battery, and which would have sufficient power to operate an ordinary foot lathe or any light machinery requiring not over one man power.

The only machine work required in the construction of the motor illustrated is the turning of the wooden support for the armature ring. The materials cost less than four dollars, and the labor is not great, although some of the operations, such as winding the armature and field magnet, require some time and considerable patience. On the whole, however, it is a very easy machine to make, and, if carefully constructed, will certainly give satisfaction.

Only such materials as may be procured anywhere are required. No patterns or castings are needed.

Beginning with the armature, a wooden spool, A (Fig. 2), should be made of sufficient size to receive the soft iron wire of which the core of the armature is formed. The wire, before winding, should be varnished with shellac and allowed to dry, and the surface of the spool on which the wire is wound should be covered with paper to prevent the sticking of the varnish when the wire is heated, as will presently be described. The size of the iron wire of the core is No. 18 American wire gauge. The spool is $2\frac{3}{16}$ inches in diameter in the smaller part, and 3 inches in length between the flanges. It is divided at the center and fastened together by screws. Each part is tapered slightly to facilitate its removal from the wire ring. The wire is wound on the spool to a depth of $\frac{3}{8}$ inch. It should be wound in even layers, and when the winding is complete the spool and its contents should be placed in a hot oven and allowed to remain until the shellac melts and the convolutions of wire are cemented together. After cooling, the iron wire ring, B, is withdrawn from the spool, and covered with a single thickness of adhesive tape, to insure insulation. If adhesive tape is not at hand, very thin cotton tape or strips of cotton cloth may be substituted. A single coat of shellac varnish will hold the covering in place.

The ring is now spaced off into twelve equal divisions, and lines are drawn around the ring transversely, dividing it into twelve equal segments, as shown in Fig. 3. Two wedge shaped pieces, C, of hard wood are notched and fitted to the ring so as to inclose a space in which to wind the coil. These blocks may be clamped in any convenient way. The coil, D, consists of No. 18 cotton covered copper magnet wire, four layers deep, each layer having eight convolutions. The end, *a*, and the beginning, *b*, of the winding terminate on the same side of the coil. The last layer of wire should be wound over two or three strands of shoe thread, which should be tied after the coil is complete, thus binding the wires together. When the first section of the winding is finished, the wire is cut off and the ends (about two inches in length) are twisted together to cause the coil to retain its shape. After the completion of the first section, one of the pieces, C, is moved to a new position and the second section is proceeded with, and so on until the twelve sections are wound. The coils of the ring are then varnished with thin shellac varnish, the varnish being allowed to soak into the interior of the coils. Finally, the ring is allowed to remain in a warm place until the varnish is thoroughly dry and hard.

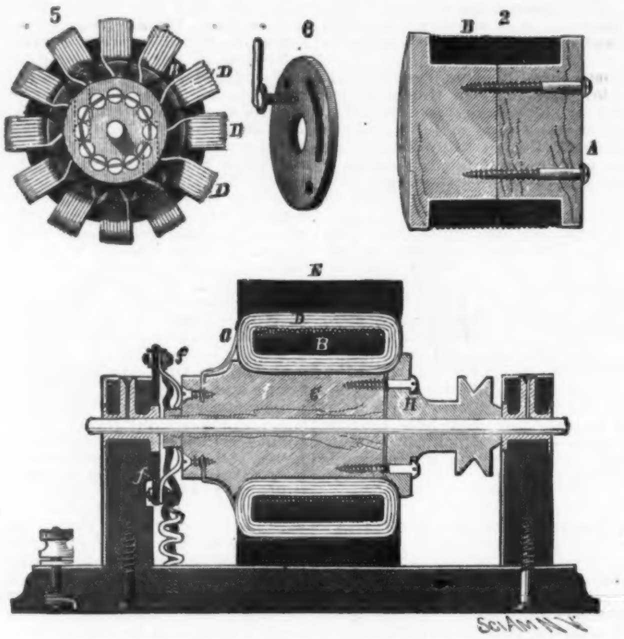
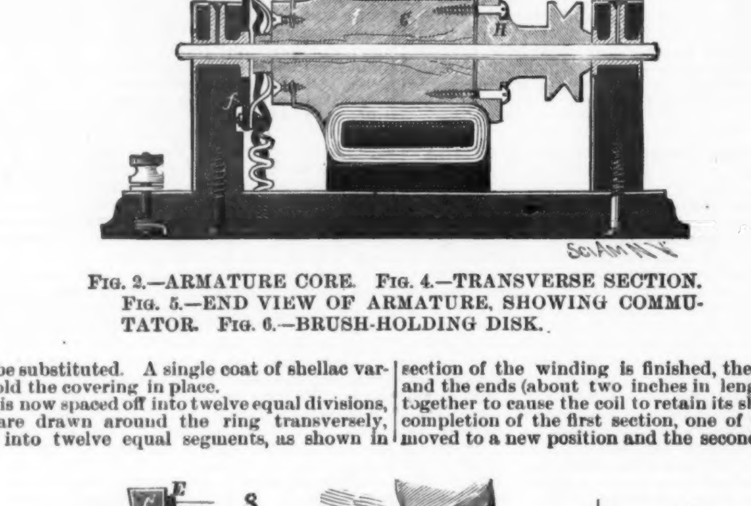


Fig. 2.—ARMATURE CORE. Fig. 4.—TRANSVERSE SECTION. Fig. 5.—END VIEW OF ARMATURE, SHOWING COMMUTATOR. Fig. 6.—BRUSH-HOLDING DISK.



Figs. 7 and 8.—FORMING THE FIELD MAGNET.

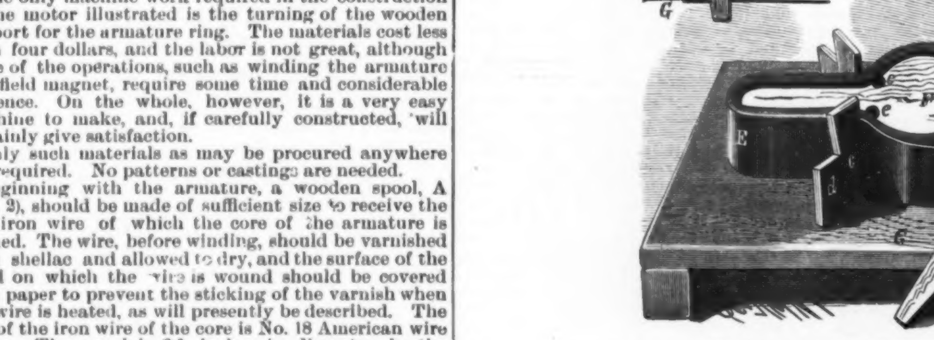


Fig. 1.—SIMPLE ELECTRIC MOTOR—ABOUT HALF SIZE.

Fig. 3.—WINDING THE ARMATURE.

Care should be taken to wind all of the coils in the same direction and to have the same number of convolutions in each coil. A convenient way of carrying the wire through and around the ring is to wind upon a small ordinary spool enough wire for a single section, using the spool as a shuttle.

The ring is mounted upon a wood support or hub, G, and is held in place by the wooden collar, H, both hub and collar being provided with a concave flange for

receiving the inner edges of the ring. The collar, H, is fastened to the end of the hub, G, by ordinary brass wood screws. Both hub and collar are mounted on a $\frac{1}{4}$ steel shaft formed of Stubs' wire, which needs no turning. A pulley is formed integrally with the collar, H. The end of the hub, G, which is provided with a flange, is prolonged to form the commutator, and the terminals, *a b*, of the ring coils are arranged along the surface of the hub and inserted in radial holes drilled in the hub in pairs. The wires are arranged so that one hole of each pair receives the outer end of one coil and the other hole receives the inner end of the next coil, the extremities of the wire being scraped before insertion in the holes. The distance between the holes of each pair is sufficient to allow a brass wood screw to enter the end of the hub, G, and form an electrical contact with both wires of the pair, as shown in Fig 4.

There being twelve armature sections and twelve pairs of terminals, there will of course be required a corresponding number of brass screws. These screws are inserted in the end of the hub, G, so as to come exactly even with the end of the hub without touching each other. This completes the armature and the commutator.

Before proceeding to mount the armature shaft in journal boxes, it will be necessary to construct the field magnet, as the machine must, to some extent at least, be made by "rule of thumb."

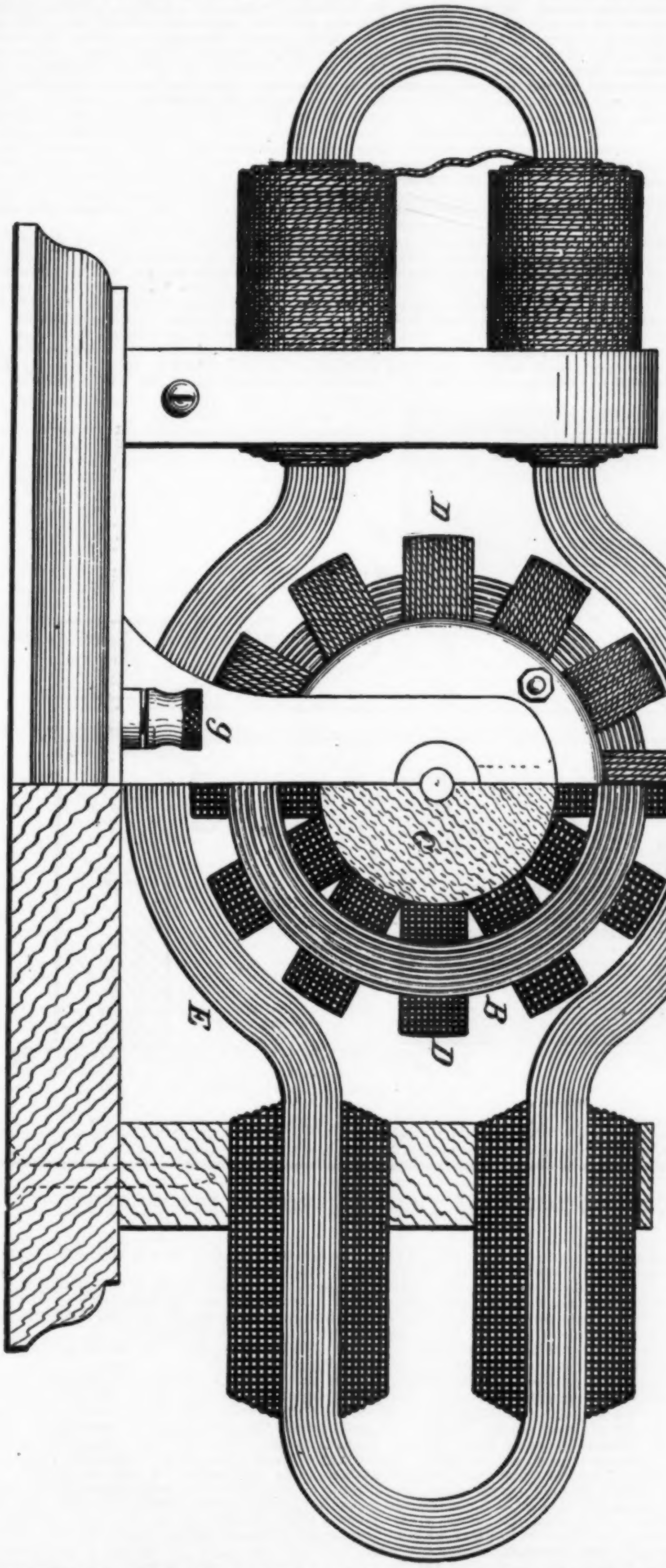


FIG. 10.—SIDE ELEVATION—PARTLY IN SECTION—OF SIMPLE ELECTRIC MOTOR—FULL SIZE.

The body, E, of the field magnet consists of strips of Russia iron, such as is used in the manufacture of stoves and stove pipe. The strips are $2\frac{1}{4}$ inches wide, and of any convenient length, their combined length being sufficient to build up a magnet core seven-sixteenths inch thick, of the form shown. The ends of the strips are simply abutted. The motor illustrated has 15 layers of iron in the magnet, each requiring about 26 inches of iron, approximately 33 feet altogether.

The wooden block, F, on which the magnet is formed is secured to a base board, G, as shown in Fig. 7, and grooves are made in the edges of the block, and corresponding holes are formed in the base to receive wires for temporarily binding the iron strips together. Opposite each angle of the block, F, mortises are made in the base board, G, to receive the keys, *d*, and wedges, *c*. Each key, *d*, is retained in its mortise by a dovetail as shown in Fig. 8. By this arrangement each layer of the strip of iron may be held in position, as the formation of the magnet proceeds, the several keys, *d*, and wedges, *c*, being removed and replaced in succession as the iron strip is carried around the block, F. When the magnet has reached the required thickness, the wedges, *c*, are forced down so as to hold the iron firmly, then the layers of iron are closely bound together by iron binding wire wound around the magnet through the grooves, *e*, and holes in the base board, G.

The next step in the construction of the machine is the winding of the field magnet. To insure the insulation of the magnet wire from the iron core of the magnet, the latter is covered upon the parts to be wound by adhesive tape or by cotton cloth attached by means of shellac varnish.

The direction of winding is clearly shown in Fig. 9. Five layers of No. 16 magnet wire are wound upon each section of the magnet. The winding begins at the outer end of the magnet, and ends at the inner end of the section. When the winding is completed, the temporary binding is removed. The outer ends of coils 1 and 2 are connected together, and the outer ends of 3 and 4 are connected. The inner ends of 2 and 4 are connected. The inner end of 3 is to be connected with the commutator brush, *f*. The inner end of 1 is to be connected with the binding post, *g*, and the binding post, *g'*, is to be connected with the commutator brush, *f'*.

The field magnet is now placed upon a base having blocks of suitable height to support it in a horizontal position. A block is placed between the coils to prevent the top of the magnet from drawing down upon the armature, and the magnet is secured in place by brass straps, as shown in Figs. 1 and 10.

The armature is wrapped with three or four thicknesses of heavy paper, and inserted in the wider part of the field magnet, the paper serving to center the armature in the magnet. The armature shaft is leveled and arranged at right angles with the field magnet. The posts in which the armature shaft is journaled are bored transversely larger than the shaft, and a hole is bored from the top downward, so as to communicate with the transverse hole. To prevent the binding of the journal boxes, the exposed ends of armature shaft are covered with a thin wash of pure clay and allowed to dry. The posts are secured to the base, with the ends of the armature shaft received in the transverse holes. Washers of pasteboard are placed upon the shaft on opposite sides of the posts, to confine the melted metal, which is to form the journal boxes. Babbitt metal, or, in its absence, type metal, is melted and poured into the space around the shaft through the vertical hole in the post. The journal boxes thus formed are each provided with an oil hole, extending from the top of the post downward. If, after cleaning and oiling the boxes, the shaft does not turn freely, the boxes should be reamed or scraped until the desired freedom is secured.

All that is now required to complete the motor is the commutator brushes, *f f'*. They each consist of three or four strips of thin hard rolled copper curved

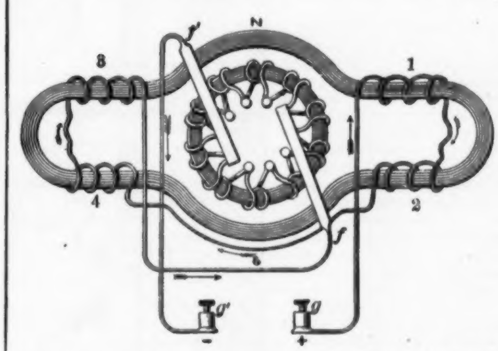


FIG. 9.—CIRCUIT OF SIMPLE ELECTRIC MOTOR.

as shown in Fig. 4, to cause them to bear upon the screws in the end of the hub, G. The brushes are secured by small bolts to a disk of vulcanized fiber, or vulcanite, at diametrically opposite points, as shown in dotted lines in Fig. 5, and the brushes are arranged in the direction of the rotation of the armature. In the brush-carrying disk is formed a curved slot for receiving a screw, shown in Fig. 6, which passes through the slot into the post and serves to bind the disk in any position. The disk is mounted on a boss projecting from the inner side of the post concentric with the armature shaft. The brushes are connected up by means of flexible cord, or by a wire spiral, as shown in Figs. 1 and 9. The most favorable position for the brushes may soon be found after applying the current to the motor. The ends of both brushes will lie approximately in the same horizontal plane. When the motor is in operation, the direction of the current in the conductor of the field magnet is such as to produce consequent poles above and below the armature, as indicated in Fig. 9.

Eight cells of plunging bichromate battery, each having one zinc plate 5×7 inches, and two carbon plates of the same size, will develop sufficient power in the motor to run an ordinary foot lathe or two or three sewing machines.

The dimensions of the parts of the motor are tabulated below:

Length of field magnet (inside)	10	in.
Internal diameter of polar section of magnet	$3\frac{1}{16}$	"
Width of magnet core	$2\frac{1}{2}$	"
No. of layers of wire to each coil of magnet,	5	
No. of convolutions in each layer	34	
Length of wire in each coil (approximate)	95	feet.
Size of wire, Am. W. G	No. 16.	
Outside diameter of armature	$3\frac{1}{2}$	in.
Inside diameter of armature core	$2\frac{1}{16}$	"
Thickness " " "	$\frac{3}{8}$	"
Width " " "	2	"
" " " wound	$2\frac{1}{2}$	"
No. of coils on armature	12	
No. of layers in each coil	4	
No. of convolutions in each layer	8	
Length of wire in each armature coil (approximate)	15	feet.
Size of wire on armature, Am. W. G	No. 16.	
Length of armature shaft	$7\frac{1}{4}$	in.
Diameter of armature shaft	$\frac{5}{16}$	"
" " wooden hub	$1\frac{1}{4}$	"
Distance between standards	$5\frac{1}{2}$	"
Total weight of wire in armature and field magnet	6	lb.

This motor is designed for use in connection with a battery of low resistance, preferably one of the plunging type, as such a battery permits of readily regulating the speed and power of the motor by simply plunging the plates more or less.

This form of battery has the additional advantages of being more powerful for its size than any other, and of being very easily cleaned and kept in order. It has, however, the disadvantage of becoming exhausted in three or four hours, but this is partly compensated for by the ease with which it may be renewed.

If it is desirable to adapt the motor to a battery of higher resistance, the armature and field magnet may be wound with finer wire. No rules can be given here for altering the proportions of the motor to adapt it to different currents, but if the motor is wound with wire of any size between Nos. 16 and 20, a battery may be adapted to it.

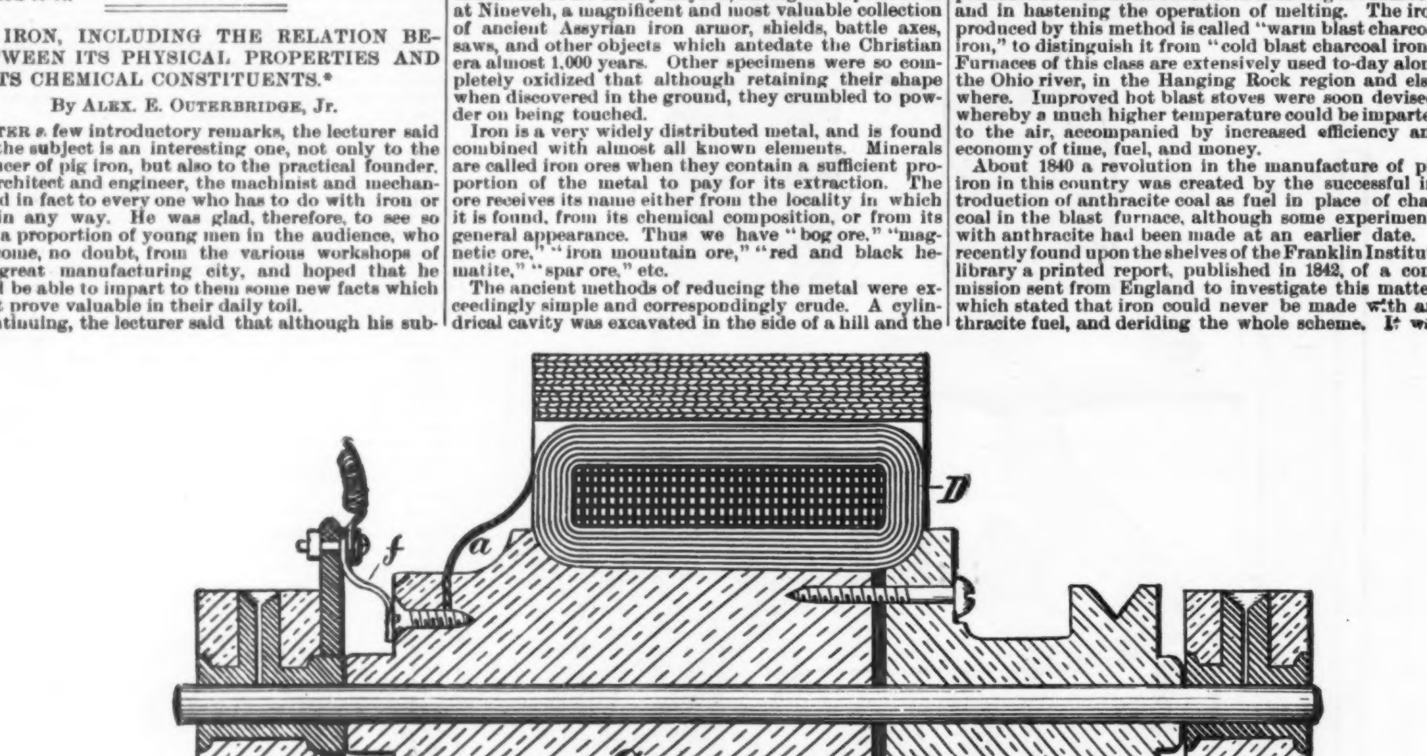


FIG. 11.—VERTICAL TRANSVERSE SECTION OF SIMPLE ELECTRIC MOTOR, TAKEN THROUGH THE CENTER OF THE ARMATURE—FULL SIZE.

PIG IRON, INCLUDING THE RELATION BETWEEN ITS PHYSICAL PROPERTIES AND ITS CHEMICAL CONSTITUENTS.*

By ALEX. E. OUTERBRIDGE, Jr.

AFTER a few introductory remarks, the lecturer said that the subject is an interesting one, not only to the producer of pig iron, but also to the practical founder, the architect and engineer, the machinist and mechanic, and in fact to every one who has to do with iron or steel in any way. He was glad, therefore, to see so large a proportion of young men in the audience, who had come, no doubt, from the various workshops of this great manufacturing city, and hoped that he would be able to impart to them some new facts which might prove valuable in their daily toil.

Continuing, the lecturer said that although his subject was a "cast iron" one, it was not devoid of literary and even of romantic features, which time would not permit him to dwell upon at any length. He then spoke substantially as follows:

It is proper, however, to indicate that the subject has a history of great antiquity and interest, and to point out very briefly this path which you may explore more fully at your leisure, and I would commend to your careful study the admirable "History of Iron in all Ages," by Mr. James M. Swank, the secretary of the American Iron and Steel Association.

The earliest records of iron are to be found in the books of the Old Testament, which make frequent allusions both to iron and steel. In the fourth chapter of Genesis, Tubal Cain is spoken of as "an instructor of every artificer in brass and iron," and the biblical chronology places this expert in the seventh generation from Adam. When David was about to build the temple (nearly 1,000 B. C.) "he prepared iron in abundance for the nails for the doors of the gates and for the joinings." An "iron pen" is mentioned in the nineteenth chapter of Job, which was used to engrave upon rocks, and in the next chapter a "bow of steel" is spoken of.

Iron was a familiar metal to the Egyptians, Chaldeans, Babylonians, Assyrians, and other ancient peoples. It is frequently mentioned by classical authors, among whom are Homer, Aristotle, and Pliny. Homer speaks of iron disks being given as prizes to the contestants in athletic games, and also of the method of tempering steel by plunging the hissing ax into cold water. Pliny knew of the magnetic qualities of iron, and alludes to the inexhaustible deposits of ore in the island of Elba and in Spain. These mines are still worked, and thousands of tons are annually shipped from them. India has been celebrated for ages for the quality of its steel, and China also claims great antiquity for the process of making iron and steel. The Chinese record minutely describing these methods is still preserved, to which almost fabulous age is accredited by archæologists.

These brief allusions must suffice to indicate the rich store of knowledge upon this branch of our subject which is available to those who have the time and inclination to pursue it to its fountain head.

It has often been asked, in view of the frequent allusions to the use of iron and steel in ancient times, "Why are iron relics of antiquity far more rare than those of gold, silver, or bronze?" If you reflect for a moment, the true explanation will be apparent. It is owing to the oxidizable character of the metal, which causes it to rust and crumble away, when exposed to the elements, in a comparatively brief period of time. However, the British Museum is fortunate to have secured, through the labors of Sir Henry Layard, during his explorations at Nineveh, a magnificent and most valuable collection of ancient Assyrian iron armor, shields, battle axes, saws, and other objects which antedate the Christian era almost 1,000 years. Other specimens were so completely oxidized that although retaining their shape when discovered in the ground, they crumbled to powder on being touched.

Iron is a very widely distributed metal, and is found combined with almost all known elements. Minerals are called iron ores when they contain a sufficient proportion of the metal to pay for its extraction. The ore receives its name either from the locality in which it is found, from its chemical composition, or from its general appearance. Thus we have "bog ore," "magnetic ore," "iron mountain ore," "red and black hematite," "spar ore," etc.

The ancient methods of reducing the metal were exceedingly simple and correspondingly crude. A cylindrical cavity was excavated in the side of a hill and the ore and fuel (charcoal) packed into it, a hole being left at the top and bottom for the draught. When the fuel was all consumed, the metallic iron was recovered amid the ashes. The *regulus* was an impure mass, sometimes resembling wrought iron, sometimes cast iron, sometimes steel, and often a mixture of all three, according as the crude process accidentally altered the proportion of carbon, silicon, etc., in the mass.

The next improvement was in the "Catalan forge," so named from Catalonia, where it originated. The forge was provided with an artificial draught of air from a rude bellows made of goat skins. Then came the invention of the earliest form of blast furnace, which was a decided improvement, owing mainly to the fact that the process of feeding the ore and fuel and reduction of the iron could be made continuous, thus effecting a considerable saving of labor and also increasing the output of metal. The blast furnace is a very simple affair, consisting of a high stack, lined with refractory clay or firebrick, oval in shape, having one or more orifices near the bottom, called *tuyeres*, for the admission of air under pressure, and an opening at the top, called the "tunnel head," for the admission of ore, fuel and flux. The fuel formerly used was charcoal, and the quality of the metal (called "pig" iron, from the shape into which it is cast as it runs from the furnace) was far superior, for certain special uses, to that made by modern processes.

I do not mean to say that I think this is necessarily so, or that it will always be true, but I am compelled to admit that, at this stage of evolution in the iron industry, modern improvements have all been in the line of increased output from a furnace with decreased consumption of fuel, but at the expense of the character of the metal and consequent depreciation of value.

In the old fashioned charcoal furnace, air was blown into it at the ordinary temperature. Furnaces of this character were commonly found fifty years ago throughout Pennsylvania, Ohio, and all through the South. We are informed by Mr. Swank that such a furnace producing four tons of iron a day, or twenty-eight tons a week, was considered to be doing well. We now regard an output of 100 tons a day from one furnace, or even 1,000 tons a week, as quite an ordinary matter. This extraordinary increase has been accomplished, not by a proportionate enlargement of the furnace, but by lessening the time of reduction of the metal, and thus increasing its capacity.

It occurred to some one more than half a century ago, that the waste heat escaping from the furnace might be utilized to warm the air blast before entering the furnace, and thus save a part of the fuel. The air was accordingly passed through iron tubes, arranged in a chamber of fire brick, and thus heated. A very moderate degree of warmth (say 300° F.) imparted to the air produced a remarkable effect both in saving the charcoal and in hastening the operation of melting. The iron produced by this method is called "warm blast charcoal iron," to distinguish it from "cold blast charcoal iron." Furnaces of this class are extensively used to-day along the Ohio river, in the Hanging Rock region and elsewhere. Improved hot blast stoves were soon devised, whereby a much higher temperature could be imparted to the air, accompanied by increased efficiency and economy of time, fuel, and money.

About 1840 a revolution in the manufacture of pig iron in this country was created by the successful introduction of anthracite coal as fuel in place of charcoal in the blast furnace, although some experiments with anthracite had been made at an earlier date. I recently found upon the shelves of the Franklin Institute library a printed report, published in 1842, of a commission sent from England to investigate this matter, which stated that iron could never be made with anthracite fuel, and deriding the whole scheme. It was quite a surprise to find such an amusing volume among these dusty archives.

Of late years, coke made from bituminous coal has been extensively used as fuel in the manufacture of mill iron, and the product is called "coke iron," to distinguish it from "anthracite iron."

What is the character of the metal produced by these different processes?

Pig iron varies so greatly in general appearance, color, hardness, ductility, tensile and tranverse strength and specific gravity, that one not having expert knowledge upon the subject might reasonably doubt that the specimens which I propose to exhibit to you, by means of the megascope, even belong to the same class of metal. One specimen is soft and ductile like lead, and shows a rich, dark color and coarse granular fracture. Another is hard as steel, brittle as glass, and white as silver, while between these extremes we have a great range of specimens having intermediate qualities.

You now see upon the screen a photograph taken from a series of "test pieces" (see illustrations, Figs. 1 and 2) made from different grades of pig iron, in moulds of uniform size, cast in "green sand," against an iron "chill plate" for the purpose of suddenly cooling one side of the casting. The pieces are arranged in a series with the chilled side uppermost, beginning with a sample which shows no tendency to produce white or chilled metal, and passing, by gradual steps, to metal which crystallizes as white iron through the whole mass. All of these specimens were cast from iron which was perfectly gray in the pig, sufficiently soft to bore readily, varying but slightly in specific gravity, and ranging in transverse strength from 5,000 to 7,000 pounds per square inch. The effect of sudden cooling has developed the white crystalline structure in some of the specimens, rendering them so hard that they cannot be touched with a file, and so brittle that they may be readily broken, and increasing their density to

* Abstract of a lecture delivered before the Franklin Institute, February 6, 1888.

such a degree that a cubic foot of the white metal weighs nearly sixty pounds more than an equal bulk of the gray iron.

Very little information has been printed in regard to the wide differences in the character of *white iron*, although it is a subject of great practical importance to the manufacturer of chilled castings, and it will, no doubt, surprise many to learn that I have found, as the result of a series of careful experiments (not yet published), that there is as wide a difference in the strength of different specimens of white iron as in those of gray iron. Moreover, there is a vast difference in the ability of white iron to resist disintegration or "spalling" under the repeated impact of hammer blows, dependent upon the molecular structure of the crystals. There is also a decided difference in the density, or specific gravity, and hardness of different specimens of chilled or white iron.

I will now show you a photograph (see illustration, Fig. 3) taken from a series of chilled iron test pieces, which were cast in iron ingot moulds made for these original experiments, in which you may observe several interesting features. The samples were all cast from gray iron, some of which showed no tendency to produce white iron when cast in the ordinary "chill moulds," yet in these small ingot moulds they are chilled throughout the mass. You will observe quite a difference in the molecular arrangement and size of the crystals, and what is still more singular, you will see in all of the square sections a plainly marked cross, or dividing lines, extending from corner to corner of the ingot.

White iron always crystallizes in planes at right angles to the chilling surface, and, as the moulds are made of iron, the crystals start from all four sides at the same instant, and meet at points equidistant from the surface, which may be called the neutral line. By splitting some of the ingots lengthwise, I have found this line extending, plainly marked, through its entire length. It is an interesting phenomenon that the line of demarkation of opposing crystalline forces should be so clearly defined. It will be noticed in the specimens cast in the cylindrical moulds that the crystals radiate from the center like the spokes of a cart wheel. Some of the specimens here shown are so brittle that the slightest tap from a light hammer will break them, while others of the same diameter require more than 100 blows to break. Some of them are much harder than others, while the difference in density amounts to nearly ten pounds to the cubic foot, as ascertained by specific gravity determinations. These experiments are novel and interesting from a scientific standpoint, while they also have a practical bearing upon the manufacture of good chilled castings.

Of what is pig iron composed that it should develop such widely varying characteristics? Is the iron itself inherently different in quality, or are these changes due to variations in the proportion of the other elements combined with it? You might suppose that you could obtain answers to these questions from practical melters or superintendents of foundries, but you will find even in the largest foundries lamentable ignorance on such points. As an extremely absurd instance, I may mention that some time ago I visited a large iron foundry, and while conversing with the foreman of the melting department, I asked his opinion of a certain brand of iron with which I was familiar. He replied: "Me and my boss wouldn't have a pig of it on the premises." On being pressed for the reason of his prejudice, he replied: "Well, sir, my opinion is, *it's got too much ammonia in it!*"

The chemistry of iron, in its connection with the manufacture of Bessemer steel, has, from the necessities of the case, been carried to a fine degree of perfection, but it is a matter of surprise that so little is known practically in the foundry and workshop, in regard to the cause of these wide variations, which are a frequent source of difficulty in manipulation of the metal, and loss of time, money, and labor. The subject is, however, beginning to attract a share of the scientific attention which has been bestowed upon the chemistry of steel, and upon which the success of that industry so largely depends.

In 1885, Dr. Percy, the eminent English metallurgist, in an address before a distinguished body of scientists, said: "It is not many years since we had to grope about to discover an analysis of pig iron, whereas now we are actually overwhelmed with such analyses. What is now wanted is the man to reduce it to law and order—to evolve from it principles for our sure guidance."

Prof. Turner, of Mason College, Birmingham, Eng., speaking on the same subject more recently, said: "All who are acquainted with the various branches of iron analysis must feel how true the foregoing remarks are in the present state of our knowledge. . . . Our knowledge cannot be considered complete until we are able to correctly estimate the mechanical value of any given specimen of which the chemical analysis is known; and conversely, when any given mechanical properties are desired, we should be able to say at once what would be the most suitable composition for the material."

Having quoted the remarks of these distinguished authorities, it may not be inappropriate to read a sentence from a brief paper of my own, antedating the above, published in the *Penn Monthly* in February, 1882, bearing upon this subject: "Manufacturers are beginning to realize that pig iron is not a simple substance, but is in reality an alloy, composed of a number of dissimilar elements; that its physical characteristics, such as strength, elasticity, etc., depend upon the percentages of these constituents, and that pure iron, like pure gold, is always the same thing physically and chemically, no matter from what source it may be obtained. We believe that the time is coming when pig iron will be sold on its chemical analysis, instead of on the crude methods of grading at present in vogue, and farther, that, as the naturalist can accurately tell the *genus* of an animal from an examination of a single bone, so the analyst will tell the physical qualities of a mass of iron from an analysis of its component parts."

The great differences observed in physical characteristics of pig iron are due, not to variation of the proportion of iron in the pig (which remains constant within a few points), but to the varying percentages of the other component elements, viz., carbon, silicon, sulphur, manganese, and phosphorus, and experience has proved that a change of less than one-half of one per cent. of one of these elements (silicon) is sufficient to make or mar the daily product of at least one important iron industry, viz., the manufacture of chilled cast iron car wheels.

We will briefly consider the effect upon pig iron of these foreign elements in the order of their relative importance.

The element which exerts the most vital influence upon the character of pig iron is carbon. This is strikingly shown by Mr. Fairbairn, who says:

"The metal in the form of cast iron, containing four per cent. of carbon, has a tensile strength of 16,000 pounds to the square inch, and is worth £3 per ton. Deprive it of this four per cent. of carbon and it becomes malleable iron, with a tensile strength of 56,000 pounds, and is raised in value to £8 per ton. But leave in it one per cent. of the carbon it originally contained, and it will have a tensile strength of at least 130,000 pounds, and its selling price rises to £50 per ton." This price, of course, refers to crucible steel at the time he wrote.

Carbon exists in pig iron in two distinct forms, and upon the relative proportion of each depends, in great measure, the character of the metal. It is present either in the form of graphite or free carbon, disseminated throughout the mass in black shining particles, in which case the iron is exceedingly soft and ductile, or it is in part or wholly combined chemically with the iron, causing the metal, when cooled suddenly, to crystallize in parallel planes, presenting a perfectly white fracture, and the metal becomes harder than steel and extremely brittle; advantage is taken of this peculiar quality in the production of chilled castings, as in cast iron car wheels, plowshares, etc.

Cold blast charcoal iron contains a larger proportion of combined carbon than warm blast charcoal, anthracite, or coke iron, hence its peculiar value for chilled work.

Pig iron contains from two and one-half to four per cent. of carbon.

Silicon stands next in importance to carbon, in respect to its effect upon the character of the metal. It exerts a controlling influence upon the chilling properties of the iron, since its tendency is to prevent the chemical combination of the carbon and iron. A very small variation in the percentage of silicon produces a prodigious effect in this particular. In a paper read before the Chemical Section of this Institute, in 1883, upon the "Genesis of a Car Wheel," I explained at some length the important bearing which silicon has upon that industry; a brief extract will suffice to indicate its scope: "The most important difference between a car wheel and any ordinary casting is the fact that the 'tread' of the wheel, viz., that part which runs upon the rail, is quite different in character from the 'plate' or main body, though cast from the same metal in one pouring. The tread, or rim, is actually harder than steel, thus enabling it to resist not only the wear upon the steel rail, but the still more destructive grip of the brakes, and its average 'life' is not far from 100,000 miles of service. The process by which the hardening of the tread is produced is called 'chilling' (see illustration, Fig. 4), ... but it must not be supposed that all irons possess this property, for it is a comparatively rare one, and little is known, even among expert iron masters, of the causes which produce it. Very recently some light has been thrown upon the subject by the aid of chemical analysis, and scientific investigation will doubtless reveal still more clearly what is as yet but dimly seen. . . . . It has been found, for example, that the substance silicon, which is always present in pig iron, exerts an extraordinary influence upon its chilling power, and a variation of less than one per cent. of silicon is sufficient to make or mar a car wheel; indeed, it has happened that an entire day's work of several hundred men has been spoiled by an excess of one-half of one per cent. of this substance creeping undetected into the mixture."

The notion has long prevailed (like many other fallacies born of ignorance) that silicon produces "blow holes" or unsound castings, but such is not the case; on the contrary, its tendency is to produce an exceedingly fluid iron, retaining its heat for a long time, owing, I believe, to the fact, not generally known, that the "specific heat" of iron rich in silicon is much higher than a similar grade of metal containing but little of that element. Unfortunately we cannot measure the temperature of molten iron accurately, but I am convinced that pig iron varies in its melting point, just as it varies in chemical composition, and that this variation extends through a range of many hundred degrees. It is a modern practice, especially in England, to substitute a small quantity of "silicon pig" in the cupola for the more expensive Scotch irons, in order to obtain soft castings from a mixture of pig iron and scrap. The proportion of silicon in pig iron may vary from three-tenths of one per cent. to three and one-half per cent.

Phosphorus as an element in pig iron tends to render the molten metal very limpid, so that it will take an extremely fine and sharp casting from the most delicate patterns. The famous Berlin castings of reproductions in iron of ancient armor and other ornamental objects are obtained by using iron rich in phosphorus, but it possesses the disadvantage of rendering the metal brittle and unfit for many practical uses. Through the kindness of Messrs. Thackara & Sons, of Philadelphia, I am able to exhibit to you some exquisite examples of Berlin ware, and also a Russian casting representing mounted Cossacks, which is as fine in detail as any bronze casting.

I do not consider it essential to use iron high in phosphorus in order to obtain these artistic effects, and in proof of the assertion I am able now to show you a most creditable experiment made by Messrs. Bureau Brothers, the bronze founders, of this city, for illustration in this lecture, from ordinary foundry iron. The specimen is shown just as it came out of the sand, and it compares favorably in delicacy of detail and fineness of texture with the finished foreign productions, while the design is a meritorious work of art.

The percentage of phosphorus in pig iron may vary from a trace to one and one-half per cent.

Manganese is commonly supposed to exert a hardening tendency upon pig iron, but experience has taught me to regard this as another mistaken notion. It undoubtedly produces a marked effect upon the character of the white crystalline structure. You may readily recognize "a manganese chill" by its coarse lamellar or foliated filaments and by the tendency which it produces to form white iron or "hard spots" in isolated places throughout the gray portion of a casting. Manganiferous pig iron has been used to produce chilled castings, but it does not make a durable wearing surface; the chilled tread of a car wheel, for example, produced by this method, presents to the eye, when broken through the section, a handsome appearance, but the white metal is comparatively soft; it may be easily bored, and, what is more serious, it crumbles readily under the impact of rapid shocks on the rail.

A remarkable effect is produced upon the character of hard iron by adding to the molten metal, a moment before pouring it into a mould, a very small quantity of powdered ferro-manganese, say one pound of ferro-manganese in 600 pounds of iron, and thoroughly diffusing it through the molten mass by stirring with an iron rod. The result of several hundred carefully conducted experiments which I have made enables me to say that the transverse strength of the metal is increased from thirty to forty per cent., the shrinkage is decreased from twenty to thirty per cent. and the depth of the chill is decreased about twenty-five per cent., while nearly one-half of the combined carbon is changed into free carbon; the percentage of manganese in the iron is not sensibly increased by this dose, the small proportion of manganese which was added being found in the form of oxide in the scoria. The philosophical explanation of this extraordinary effect is, in my opinion, to be found in the fact that the ferro-manganese acts simply as a deoxidizing agent, the manganese seizing any oxygen which has combined with the iron, forming manganic oxide, which being lighter than the molten metal, rises to the surface and floats off with the scoria. When a casting which has been artificially softened by this novel treatment is remelted, the effect of the ferro-manganese disappears and hard iron results as a consequence.*

The percentage of manganese in pig iron may vary from a mere trace to two per cent., or even more.

Sulphur is, without doubt, the most deleterious substance found in pig iron. The other elements all produce effects which may be beneficial for certain purposes, but sulphur is an enemy greatly to be dreaded, since it has a strong affinity for iron, combining with it at a low temperature; it is even possible to bore a hole in red-hot iron by means of a stick of sulphur, yet I have actually seen shrinkage holes and cavities in imperfect castings filled with a composition of melted sulphur, the manufacturer failing to appreciate the deleterious effect which this material will produce upon the iron when the worn-out casting comes back to be remelted, and this is but one of many blunders which are committed through ignorance on the part of practical founders.

The presence of sulphur in pig iron is due mainly to bad fuel or to imperfect roasting of the ores containing that element, or to improper fluxing. The proportion of sulphur in pig iron may vary from a mere trace to more than one-half of one per cent.

These various elements all produce sufficiently marked effects upon the fracture and general appearance of pig iron to enable an expert, who carefully studies the matter in connection with the analysis of the iron, to estimate by the eye the approximate composition of any given sample within a surprisingly close margin of error. In the case of silicon, I have found by frequent tests that it is possible to predict the percentage of that element within three-tenths ($\frac{3}{10}$) of one per cent. of the actual amount subsequently reported by chemical analysis, and although I have not yet succeeded in estimating with equal success the proportion of the other component elements of pig iron, I believe the method by inspection is susceptible of great development.

Traces of other elements are also found in pig iron, but these do not appear to exert a very important influence upon the character of the metal, and cannot be considered in detail at this time.

It is difficult to define the line of demarkation between pig iron, steel, and malleable iron, since one blends almost insensibly into the other. The following table represents fairly well the extreme variations in composition of these three forms of iron:

	Pig Iron.	Steel.	Malleable Iron.	
Iron	90 to 95	98·5 to 99·5	99 to 99·5	per cent.
Carbon	2·5 to 4	1·5 to 0·5	0·1 to 0·5	"
Silicon	0·2 to 3·5	Tr. to —	0 to Tr.	"
Sulphur	Tr. to 0·5	Tr. to —	0 to Tr.	"
Phosphorus	Tr. to 1·5	Tr. to —	0 to Tr.	"
Manganese	Tr. to 2	Tr. to 2	0 to Tr.	"

The development of the iron industry in the United States has been truly marvelous. In 1810 we produced less than 54,000 tons of pig iron; in 1840, less than 300,000 tons; 1860, less than 900,000 tons; in 1885, over 4,000,000 tons; in 1887, 6,417,148 tons, made in twenty-three States and Territories, of which Pennsylvania alone produced 3,684,618 tons, or a little over one-half of the total amount. It would thus appear that the agitation over the fear that our State is losing its supremacy as a producer of pig iron is refuted by the facts so carefully gathered by Mr. Swank. In addition to this vast production, we imported last year nearly 500,000 tons of foreign pig iron, besides 283,836 tons of "tin plates," or thin rolled iron coated with tin.

Notwithstanding the progress we have made in every other branch of iron industry, we make almost no tinned iron. Why? Ah! thereby hangs a tale, with a moral appended, which may be respectfully referred to the present administration.

It appears that in the tariff act of 1864, Congress passed a law providing that the duty on "tin plates, and iron galvanized or coated with any metal by electric batteries or otherwise," should be two and one-half cents per pound. Now, "tin plates," as you all know, does not mean sheet tin, but *sheet iron coated with tin*, and is the material of which all tinware is made. The plain object of this duty was to encourage the establishment of rolling mills for the production of the sheet tinned iron in this country, and, as we had no native tin, it was desirable to place a comparatively low duty upon that metal. Another clause in the same

* A few years ago, Mr. William Wilmington, of Toledo, O., patented a process for softening the hubs and plates of car wheels without affecting the chilled tread by sprinkling powdered ferro manganese into the head box after the mould is partly filled. It is claimed that new wheels are being made in this manner out of old wheels without the use of pig iron. Mr. Wilmington's patents do not cover the process of softening hard iron in the manner described above.

act provided that the duty on "tin in sheets or plates, terne or taggers' tin," should be fifteen per cent. *ad valorem*. Soon after the passage of this law, the collector of the port at New York applied (as is stated in the Chicago *Inter-Ocean*) to the then secretary of the treasury for a ruling upon the duty on "tin plates." The secretary replied, under date of July 22, 1864: "It would appear that an error of punctuation has been made by some one, most probably by the clerk who engrossed that part of the act. If the comma after the word 'plates' be omitted, and a comma inserted after the word 'iron,' the true sense will be apparent, which unquestionably is that tin plates must be galvanized or coated with some other metal to bring them within this provision." The secretary then applied the second clause relating to tin in sheets or plates to the case, so that the duty, instead of being two and one-half cents per pound, was assessed at fifteen per cent. *ad valorem*. The immediate result of this ruling was to give an immense impetus to the business in England, more than fifty rolling mills were established for making tin plates for the American market, and ever since that date we have been consuming more than two-thirds of the entire English production of tin plates, for which luxury we have paid more than $250,000,000 to our English cousins.

in most of these products we lead the world both for excellence of workmanship and economy of production.

In the field of artistic cast iron work we have scarcely made an opening. It is in this direction that I think the greatest opportunity for developing the skill and ingenuity of our young mechanics may be found, and for this reason I have taken the pains to secure specimens of the finest foreign work, and also of our home productions, for your inspection.

Our thanks are due to the various manufacturers who have contributed these interesting and beautiful specimens, and on my own part I desire to thank you for the close attention you have accorded to the subject, as well as for the cordial appreciation of my effort which you have shown.

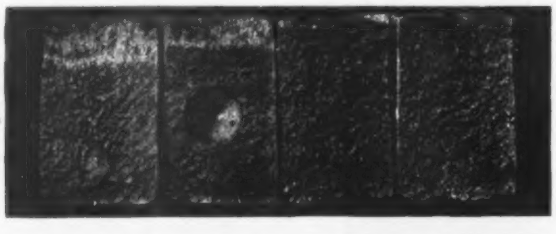
EXPLANATION OF PLATE.

Figs. 1 and 2 show eight "chill test" samples, cast from different specimens of gray iron arranged in a graduated series, ranging from one showing no tendency to crystallize as white iron to one which chills white throughout the sample.

Fig. 3 shows the remarkable crystalline structure of white iron ingots cast from gray metal in iron moulds; the crystals forming at right angles to the chilling surface, reveal a well defined line of demarkation at points equidistant from the surface.

Fig. 4 shows a broken section of a chilled cast iron car wheel, cast in a "green sand" mould, provided with an iron ring, or "chill," producing a chilled or hard iron tread, with a soft gray iron hub, plate, and arms.

1



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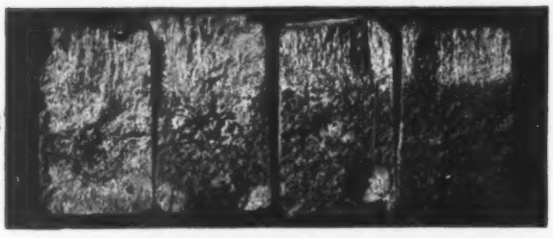

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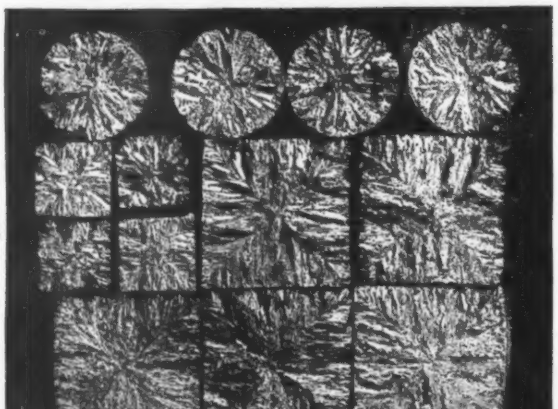

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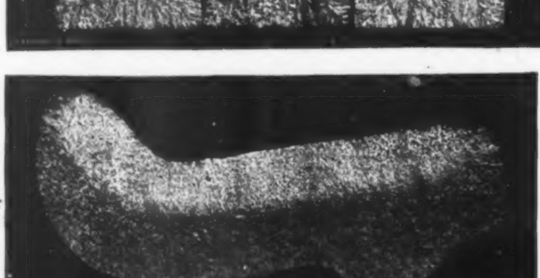


Let us turn now to a more pleasing chapter in the history of the development of the iron industry, viz., the manufacture of Bessemer steel, which has grown in the past twenty years from an insignificant beginning to one of gigantic proportions. In 1867, the first steel rails were made in this country at a cost to the consumer of $170 a ton. In 1881, we made 1,355,519 tons, at a cost of $61 a ton. In 1886, we made 2,000,000 tons, at a cost of about $30 a ton, and in 1887 our output was still larger.

Having briefly reviewed the early history of iron and the methods of extraction, the character of the metal as determined by its composition, and the enormous development of the industry in recent years, it is fitting that we should consider in conclusion the various uses to which this product is applied.

We are told that the equipment of railways consumes more than one-half of the world's production of iron, and when we consider that we have more miles of railway in the United States than any other country, or, indeed, the whole of Europe, we can begin to appreciate the magnitude of the needs for the raw material. It is estimated that there are more than *ten million car wheels* required to furnish the rolling stock in this country, these alone consuming more than 2,000,000 tons of iron.

In the manufacture of stoves, ranges, cooking utensils, iron pipe, rolled iron, nails and spikes, firearms and cutlery, sewing machines, fire proof safes, steam fire engines, pumps, hammers, elevators, planers, saws, axes, general hardware, machinery and all kinds of machine tools, we consume vast quantities of iron, and

EXPLOSION OF HYDROGEN AND OXYGEN BY ELECTROLYSIS.

AT a recent meeting of the Berlin Physical Society, Professor Oettingen, of Dorpat, spoke on the explosion of a mixture of hydrogen and oxygen obtained by electrolysis.

As is well known, Bunsen has advanced the following view, based on his experiments, on the explosion of electrolytic gas. By the explosive union of the oxygen and hydrogen, when the spark is passed, a temperature of 3,000 degrees C. is produced, the water formed being at once dissociated at this temperature; the temperature of the mixture of gases formed by the dissociation then falls, whereupon a new union between the two takes place, and so on; hence the explosion of electrolytic gas is to be regarded as made up of a series of partial explosions following each other in rapid succession. The speaker had intended several years ago to subject Bunsen's theory to an experimental investigation, and hoped to be able to analyze the phenomenon by the use of a rapidly revolving mirror. As a matter of fact, when the mirror was rotated at a suitable speed, the image observed was not that of a single narrow strip of light, but was rather of considerable width; it was not found possible to interpret this image, notwithstanding that the somewhat complicated experiments were repeated many times.

An endeavor was next made, with the assistance of a photographer, to obtain a record of the image, which was equally unsuccessful. He then underwent a course of photographic study; and when he had acquired sufficient experience, he last year repeated his former experiments, with a positive result, using the new methods of sensitizing the plates for the less refractive parts of the spectrum, and the most sensitive possible dry plates. The speaker had further shown, by a spectroscopic examination of the light emitted during the explosion of electrolytic gas, that the light is due, not to the combustion of the gases, but of sodium, which is doubtless accounted for by the incandescence of small particles of glass torn off by the passage of the sparks. He hence introduced, in accordance with the method of Dewar and Liveing, portions of finely powdered salts of various metals, such as copper, zinc, lithium, and cadmium, etc., into the eudiometer in which the explosion of the electrolytic gas was to be made, and now obtained not only excellent spectra of the respective metals, but also quite distinct photographs of the images in the rotating mirror. A plane mirror was used, placed at fixed distances from the eudiometer and camera, which projected the images of the successive events taking place during the explosion on to the flat, sensitized plate.

The speaker exhibited a series of the photographs thus obtained; these presented the following appearances, most clearly when the salt used was chloride of copper: In the first place, a bright point, corresponding to the place of passage of the spark, from which a short, bright ray passed both upward and downward in the tube; then, secondly, at a fixed distance from this, and occupying the whole length of the eudiometer, a bright image intersected lengthwise from end to end by zigzag lines and transversely by parallel sinuous waves. The speaker interpreted the above images by referring the intersecting zigzag lines to a series of waves of impulse caused by successive explosions; he considered, on the other hand, that the sinuous waves are due to the small particles of the metal which are set in motion by the impulse waves, and hopes to render this explanation still more probable by a new series of experiments on the explosion of carbon disulphide.

According to Professor Oettingen, the experiments of Berthelot and Vieille, and of Mallard and Lechatelier, have no bearing upon the explosion which he has studied, occurring as it does in a few thousandths of a second, but refer to the combustion which occurs subsequently to the explosion.

THE LUNAR ECLIPSE OF JANUARY TWENTY-EIGHTH.

At Algiers, Observations of Mr. Trepied, Director of the Observatory.—At 9 h. 42 m., mean time of Algiers, the shadow was distinctly seen upon the limb of the disk. At 9 h. 56 m. the shadow was grayish in its interior parts and browner at the limb. The limb of the moon covered by the shadow was much more brilliant than the other parts distant from the disk. At 10 h. 21 m. the eclipsed limb assumed a red tint, which had its maximum of intensity in the pole angle 45°. At 10 h. 43 m. 38 s. began the totality. To the naked eye the copper-red tint was very beautiful. In a telescope of 0·5 meter aperture the disk appeared yellow. At 13 h. 23 m. 20 s., exit from the shadow.

From a physical point of view, the characteristic feature of this eclipse appeared to be the copper-red color of the disk. It is well to remark that this color has never been observed in any former eclipse. Thus, to cite but an example, during the total eclipse of October 4, 1884, the color of the disk was distinctly blue. In this case, however, the appearances noted by different observers were quite divergent. It will be interesting to compare the observations made in this line at the last eclipse.

Mr. Thomas, Professor of Physics at the Algiers School of Sciences, charged with the spectroscopic examination of the eclipsed part of the disk, ascertained the following facts: Immediately on the edge of the shadow, the violet of the spectrum grew faint, and the relative faintness of the red was much less. A little further ahead in the shadow, the color seen by the naked eye was greenish blue. The spectrum was reduced to a band beginning in the vicinity of D, ending near F and beyond, with a very marked maximum toward the line E. This is a feature that does not appear to have been noted in previous eclipses. Moreover, no electric absorption appeared that was worthy of being noted.

At the Paris Observatory.—The sky was observed at the beginning of the phenomenon. The entire duration of totality was employed in the observation of occultations of stars for the purpose of determining the diameter and parallax of our satellite.

During the totality of the eclipse, the moon appeared much more luminous than it has in previous eclipses. Its brilliancy was greater than that of Sirius, while at the time of the total eclipse of Feb. 27, 1877, it was less than that of Procyon.

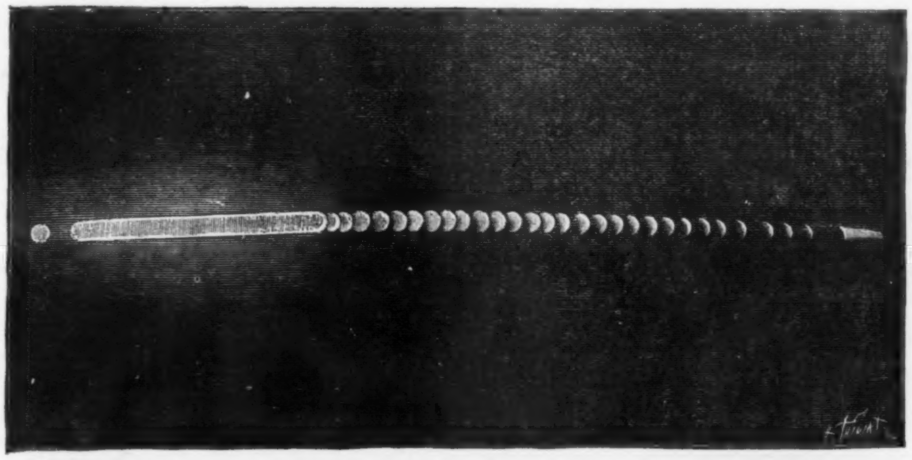
At Nice.—Mr. Perrotin, director of the observatory, observed the eclipse through a very clear atmosphere. The moon did not cease to be visible during the entire period of the phenomenon. At the moment of totality the limb and the principal craters were seen. The limb was of a bright yellow, and the center was copper colored.

At Nancy.—Mr. P. Dumont, chief of the laboratory of physics of the faculty of medicine, conceived the idea of registering the progress of the phenomenon by photography through a process that had already been employed by various observers, and a description of which will certainly interest amateur photographers. The process consists in leaving to the moon itself the care of fixing upon a photographic plate, exposed for the entire period of the eclipse, a representation of its course shown by a luminous band standing out from the dark heavens with a width proportional to its apparent diameters, decreasing while entering the cone of shadow, reduced to naught during the duration of the eclipse, and increasing on making its exit from the shadow.

On another hand, in order to render the different phases of the eclipse evident at definite intervals, the

exposure was arrested and then resumed for a few instants, and so on, so as to give a series of isolated images of the more or less hollowed out lunar disk. It was with the help of Mr. A. Bergeret that he succeeded in obtaining the interesting negative herewith reproduced.

The kind of objective or camera is of little consequence. Three apparatus were directed toward the moon as early as 8 o'clock in the evening, although the phenomenon was not to begin till 8 h. 38 m. of the meridian of Paris. The sky was cloudy when the eclipse began, and it was not till 9 o'clock that the operators uncovered the objective to take advantage of a clear spot. In the first part of the phenomenon, from 9 h. to 11 h. 29 m., the exposures for the first impressions were alternately four seconds with shutter open, five minutes with shutter closed, open again four seconds, closed again five minutes, then open twenty minutes without interruption. This gave : 8 h. 58 m., open four seconds, closed until 9 h. 3 m.; 9 h. 3 m., open four seconds, closed till 9 h. 8m.; 9 h. 8 m., open till 9 h. 30 m., then closed five minutes; 9 h. 35 m., open four seconds, closed till 9 h. 40 m.; 9 h. 40 m., open till 10 h.; 10 h., closed five minutes; 10 h. 5 m., open four seconds, closed till 10 h. 10m.; open till 10 h. 30 m.; and so on until 11 h. 29 m.



INTERMITTENT PHOTOGRAPH OF THE LUNAR ECLIPSE OF JANUARY 28.

The apparatus were given an inclination of 57° with respect to the vertical and in a south-southeast direction.

At Bordeaux.—The total eclipse was observed by Mr. G. Rayet, director of the Bordeaux observatory, the atmosphere being relatively favorable. There was an entire absence of clouds, but the sky remained slightly hazy, and, before as well as after the eclipse, a slight halo was to be seen around our satellite. The well known copper-red color of the moon was very perceptible. The star, moreover, never entirely disappeared, either to the naked eye or in the telescopes, and the eastern and western limbs of it remained all the time unequally illuminated. A large number of stellar occultations were observed during the totality of the eclipse.

At Muges (Lot-et-Garonne).—Mr. Henry Courtois writes us that the red light during totality was very intense, and the moon presented to the naked eye the aspect of a red-hot cannon ball amid brilliant winter constellations. In the telescope, the observer could distinguish the principal details of the lunar surface. The moon, situated in Cancer, was in a region very rich in stars, and fine occultations took place during totality.—*La Nature.*

THE PETROLEUM DEPOSITS OF GALICIA.

As the petroleum deposits of Galicia are not nearly so well known as those of Pennsylvania and the Caspian Sea in Russia, it is with pleasure that we receive the very interesting information on this subject communicated to us by Mr. Steinmann, one of the engineers in charge of the exploitation of one of the most important deposits at Zagorzany.

Beginning in Upper Silesia, the Carpathian Mountains form an immense curve, the north side of which presents a continuous series of petroleum beds. This side limits Austrian Galicia. The general deposit of mineral oils existing in these localities is formed of a multitude of smaller ones, all parallel with the Carpathian chain. As a whole, it is about 180 miles in length by 18 in width. A bituminous substance has long been known in Galicia, and has been worked by the peasants, who use it for lubricating their carts. It was not till about 1830 that a substance called ropa (crude oil) began to be collected in Galicia. This was used for making asphalt and an illuminating oil. It appears that the first petroleum lamp in the world was burned at Cracow, the ancient capital of Poland.

At first, the exploitation of the oil was carried on in a very crude manner and at small depths. In most cases the oil was found in the eocene and miocene of the tertiary formation. The method of boring employed from the first is as follows:

A well 5 or 6 feet square is first dug with a pick. In some cases, the petroleum begins to infilter at once. On reaching a certain depth, the sides of the well are lined with timber. A blower, operated by manual power, sends the necessary amount of air to the workman at the bottom, and produces sufficient ventilation. The work is continued, and, if necessary, a second and third course of timbering is put in. It very often becomes necessary to use powder to open a passage through hard rocks. This work is exceedingly dangerous, in consequence of the presence of hydrocarbureted gases. With this method, a depth of 325 feet is sometimes reached. If there is oil in sufficient quantity, it is extracted with a pump or with a windlass and bucket. In most cases the work is continued with the ground auger, or with the Fabian drill, as far as to the petroleum grit. All this work is done by hand, and is, therefore, exceedingly slow. It has sometimes taken five years to drive a well.

Petroleum is found in Eastern and Western Galicia in a porous, yellowish sandstone filled with crude oil. The stone is soft to the touch, and is very quickly recognized by the well borers. It is found at depths of from 325 to 1,150 feet. The deepest beds always contain the best oil, that is to say, the most illuminating oil. It is thought that there are three strata lying one over the other at intervals of from 150 to 300 feet. The wells do not spout, and are called pumping wells. To predict the presence of oil, from a geological standpoint, is difficult, if not impossible, on account of the land being so upheaved. The deposits of Central Galicia are found in pockets, and in these there is a chance of having spouting wells. Of this kind is the one at Wielzrno, which we illustrate herewith. There are others at Kryg, Libusza, Polanka, Sloboda, etc.

In the district of spouting wells, such as those of Wielzrno, Polanka, etc., various systems of boring are employed. The one that gives the best result is the Canadian. This system is exceedingly simple—wooden rods, no free fall instrument, only a strong guide. Nothing but screw tubes are used, thus wonderfully hastening the work. But the special advantage of this system lies in the use of the friction windlass. In general, the Canadian method of exploiting petroleum, introduced by Messrs. Bergheim & MacGarwey, is certainly the most favorable, and so is everywhere adopted. An English company has settled at Polanka, and is busy putting up fifty apparatus of this system. The system comprises a portable engine of from 10 to 15 horse power, which drives from 30 to 40 wells at once through an exceedingly simple mechanism. The entire mechanism operates through traction, and the stresses are so arranged as to counterbalance each other. As a consequence, the engine has to overcome friction only. There is nothing more curious than to see thirty working beams operating with perfect unison over a great extent of ground. The wells are driven at a distance of from 90 to 125 feet from each other. The oil obtained is led by pipes into wooden reservoirs, in which it deposits the water that almost always accompanies crude petroleum. There is a law that forbids water from above from being allowed to enter the petroleum strata. In fact, water, through the difference in density (water 1,000, petroleum 780), drives the oil into the sandstone, floods the well, and often injures the neighboring wells. To obviate this, the operation called "cutting off the water" is performed when the petroleum-bearing rock is nearly reached. A series of tight tubes is driven down, and a joint is made, thus preventing the upper levels of water from entering the stone. The boring is then continued. After the petroleum has stood for a few hours, the water is drawn off from the bottom of the reservoir. For the spouting wells it is another operation. Here, also, the water is intercepted. When the oil and gas begin to come in abundance, the space around the bore hole is entirely cleared, so that the men may not be asphyxiated, and can escape if occasion requires it. If the quantity of oil is too great, and prevents further drilling, all the instruments are removed, and the tube is closed with a screw cap provided with a cock, and, through a maneuver of the latter, and by means of a conduit, the oil is led to various reservoirs. In these latter the petroleum frees itself from gas and from water, if there is any.

For some distance all around, all fire is forbidden, as an explosion of the gases is very dangerous. Despite all precautions, pipes and matches have already occasioned several accidents.

From the reservoirs the petroleum is led to the refineries. At Sloboda, etc., various pipe lines are laid, and Messrs. Bergheim & MacGarwey are now laying one from Wielzrno to Krosno station. These pipe lines evidently constitute the easiest and cheapest mode of transportation.

The pumping wells, like the spouting ones, are nearly always accompanied with gas, which is collected and used for heating the boilers. With a little wood and this gas in the furnace, an excellent and very economical heat is obtained. At night the gas is used for lighting the works.

Austrian Hungary annually consumes more than a million barrels of refined petroleum. In 1886 Galicia furnished nearly half of the crude oil necessary for such consumption. The tax collected by the government of Austrian Hungary on the entire consumption of 1886 amounted to $3,000,000. The surplus oil imported into Austria comes from Bakoo. A few brands come from America.

Several excellent brands are known in Galicia, among others that of Ad. de Skvzinski, of Libusza.

Two large refineries were constructed last year, one by Count de Lavisch, at Odessa, and the other by Messrs. Bergheim & MacGarwey, at Zagorzany. Each of these is capable of producing 1,000 barrels a day.

The petroleum industry in Galicia, although young, is already an extensive one, and merits having the attention of our readers called to it.—*La Nature.*

THE MANAGEMENT OF SIMPLE CONSTIPATION.

In the *Lancet* for January 1, 1887, Sir Andrew Clark formulates the following brief and concise rules for the management of simple constipation:

1. On first waking in the morning, and also on going to bed at night, sip slowly from a quarter to half a pint of water, cold or hot. 2. On rising, take a cold or tepid sponge bath, followed by a brisk general toweling. 3. Clothe warmly and loosely; see that there is no constriction about the waist. 4. Take three simple but liberal meals daily; and, if desired, and it does not disagree, take also a slice of bread and butter and a cup of tea in the afternoon. When tea is used it should not be hot or strong, or infused over five minutes. Avoid pickles, spices, curries, salted or otherwise preserved provisions, pies, pastry, cheese, jams, dried fruits, nuts, all coarse, hard, and indigestible foods taken with a view of moving the bowels, strong tea, and much hot liquid of any kind, with meals. 5. Walk at least half an hour twice daily. 6. Avoid sitting and working long in such a position as will compress or constrict the bowels. 7. Solicit the action of the bowels every day after breakfast, and be patient in soliciting. If you fail in procuring relief one day, wait until the following day, when you will renew the solicitation at the appointed time. And if you fail the second day, you may, continuing the daily solicitation, wait until the fourth day, when assistance should be taken. The simplest and the best will be a small enema of equal parts of olive oil and water. The action of this injection will be greatly helped by taking it with the hips raised, and by previously anointing the anus and the lower part of the rectum with vaseline or with oil. 8. If by the use of all these means you fail in establishing the habit of daily or of alternate daily action of the bowels, it may be necessary to take artificial help. And your object in doing this is not to produce a very copious dejection, or to provoke several smaller actions: your object is to coax or persuade the bowels to act after the manner of nature by the production of a moderate more or less solid formed discharge. Before having recourse to drugs, you may try, on waking in the morning, massage of the abdomen, practiced from right to left along the course of the colon. And you may take at the two

PETROLEUM WELLS AT WIELZRNO, AUSTRIA.

greater meals of the day a dessertspoonful or more of the best Lucca oil. It is rather a pleasant addition to potatoes or to green vegetables. 9. If the use of drugs is unavoidable, try the aloin pill. Take one half an hour before the last meal of the day, or just so much of one as will suffice to move the bowels in a natural way the next day after breakfast. If it should produce a very copious motion, or several small motions, the pill is not acting aright; only a fourth, or even less, should be taken for a dose. When the right dose has been found it may be taken daily, or on alternate days, until the habit of daily defecation is established. Then the dose of the pill should be slowly diminished, and eventually artificial help should be withdrawn. The aloin pill is thus composed: ℞ Aloinæ, ½ gr.; extr. nucis vom., ½ gr.; ferri sulph., ½ gr.; pulv. myrrhæ, ½ gr.; saponis, ½ gr. Fiat pil. 1. If the fæces are dry and hard, and *if there is no special weakness of the heart*, half a grain of ipecacuanha may be added to each pill.

Should the action of the pill be preceded by griping and the character of the action be unequal, half a grain of fresh extract of belladonna will probably remove these disadvantages. If the aloin pill gripes, provokes the discharge of much mucus, or otherwise disagrees, substitute the fluid extract of cascara sagrada, and take from 5 to 20 drops in an ounce of water either on retiring to bed or before dinner. And when neither aloin nor cascara agrees, you may succeed by taking before the midday meal 2 or 3 grains each of dried carbonate of sodium and powdered rhubarb.

The exact agent employed for the relief of constipation is of much less importance than its mode of operation. If, whatever the agent may be, it succeeds in producing after the manner of nature one moderate formed stool, it may be, if necessary, continued indefinitely without fear of injurious effects.

THE TREATMENT OF HYDROPHOBIA BY HYPOSULPHITES.

By A. H. NEWTH, M.D., lately Medical Officer, County Lunatic Asylum, Haywards Heath.

HYDROPHOBIA is, without doubt, the result of a specific poison introduced into the blood. It is probable that this poison is of the nature of micro-organisms somewhat akin to those observed in septicæmia. Possibly future investigations may discover a specific form of micrococci, bacteria, etc. Therefore, it seems reasonable to suggest the administration of some drug which will destroy these organisms. Nearly thirty years ago Professor Polli, of Milan, suggested the use of sulphurous acid in cases of icorrhæmia. He proved by experiment that dogs who had putrid blood injected into their veins quickly died. But if hyposulphite of sodium was previously mixed with the blood, they were not affected. Further, if the hyposulphite was administered to the dogs either before or immediately after the injection of putrid blood, they did not suffer.

I have used this remedy repeatedly in cases of blood poisoning with most marked success. For instance, a patient has received a punctured wound which has inflamed, the lymphatics have become swollen and reddened, the parts are extremely painful, and there are rigors. Within a short time after the exhibition of the hyposulphites the pain has decreased, the parts are less inflamed, and all the symptoms of poisoning have abated. During a post mortem examination I accidentally punctured my hand; shortly after a red spot appeared on the site of the injury, which enlarged and became very painful, my hand and arm swelled, and I felt very ill. I examined some of the serum from the pustule under the microscope, and found it teeming with micrococci and bacteria in rapid motion. After taking several doses of hyposulphite the pain almost ceased, and the micrococci were seen to be perfectly motionless. The swelling soon subsided, and I experienced no ill effects, though the pustule took some time longer to heal.

Professors Braun and Bernatzik have asserted that the hyposulphites, being nauseous in taste and producing irritation of the bowels, are therefore not suitable for internal administration. My experience has proved the fallacy of those assertions, for I find even children take them readily, and I have never met with the slightest unpleasant symptoms from their use. Probably this may in some measure be due to the fact that I am in the habit of prescribing the hyposulphites in combination with bicarbonate of soda and sulphate of magnesia in peppermint water. For children I simply give it with sirup and caraway water. Though my experience is not sufficient to establish the value of this remedy decidedly, it is so far satisfactory that I unhesitatingly prescribe it in any cases where there seem to be symptoms of blood poisoning. In aphthæ, for instance, it seems to work like a charm, and in boils, scrofulous abscesses, etc., it really appears to do great good. I have also prescribed it with success in diphtheria and puerperal fever. It seems to me that, as hydrophobia is without doubt a form of septicæmia, the hyposulphites might do good in this terrible disease. They certainly could do no harm, and therefore I would suggest a fair trial of this remedy, not only when the disease has developed itself, but as a prophylactic. After a bite by a mad dog I would give five or ten grains of the hyposulphite of sodium or magnesium (the latter is richer in sulphurous acid) for the first three or four days every four hours; then three times a day for a week; then twice a day for another week; then every morning early for one month; recommending a Turkish bath twice a week. When the disease has developed I would prescribe the hyposulphite every hour or every two hours, with vapor or dry hot air baths, or prolonged warm water baths containing some hyposulphite in solution. The hypodermic injection might also be tried, especially if the patient is unable to swallow. In other cases the sulphurous gas might be given per rectum. By such means as these I firmly believe hydrophobia may be cured, and trust that those who have the opportunity to do so will try them. —*Lancet.*

RADICAL CURE OF ALVEOLAR ABSCESS BY INJECTION OF GUTTA PERCHA SOLUTION.*

By D. R. JENNINGS, D.D.S.

ALVEOLAR abscess in the quite recent past and at the present time is pressing its claims upon the attention of the dental profession, and like every other truth which has a practical bearing, and tends to the alleviation, elevation, and purification of humanity, must in its apprehension and reception pass through its incipiency and development to maturity; it will in its different stages of advancement meet with quick, generous, or unfriendly opposition. As has been remarked by some one, alveolar abscess has no written history. The pathology of alveolar abscess is characterized by inflammation presenting distinct stages, irritative, congestive, and exudating. The first is purely that of an irritant; the second is characterized by intense redness, increased heat with pain and local swelling; this is followed by the third and last stage, the exudating or pus-discharging—*i. e.*, suppuration. Now it has arrived at the first real stage of alveolar abscess, and I think demands an entirely different and distinct treatment from any that I have seen written or taught by any of our practitioners. In this matter I want to thoroughly impress upon the profession that this treatment is for the curing of alveolar abscess, not for simply congested or sore teeth, or inflamed periosteum; although I think it the best treatment in such cases I have ever had anything to do with.

You must always remember that in this treatment, like all others, to arrive at success you must be very thorough, leaving nothing to *luck*. You will remember also that there can be no alveolar abscess unless there is absorption of the alveolus, and that this absorption makes a cavity, and that cavity must be disposed of to effect a cure. My plan of procedure in such cases is: As soon as there is an abscess formed you will find, if you extract the tooth, that the root of the tooth has become denuded of its periosteum where the sac is attached. The objective point is to get rid of the abscess and restore to a healthy condition.

After trying all the remedies recommended by others, and having failures in quite a large per cent. of cases, I tried the plan of filling the whole of the abscess cavity and root canal with a solution of gutta percha in chloroform. To make this, take a portion of base plate gutta percha; cut it into small pieces and put into a bottle containing chloroform, enough to make a paste of the consistency of thin cream. Clean the pulp chamber, root canal, and abscess cavity thoroughly—exhausting all the pus from the sac at and around the roots—wash with alcohol and water equal parts, or with peroxide of hydrogen; dry as well as you can. Then with one of Donaldson's little bristles, made for cleansing root canals, with cotton fibers wrapped around it, dip into the gutta percha solution and introduce into the pulp chamber and root or roots as the case may be, using the cotton-wrapped broach as a piston to pump the solution through the root canal into the cavity of the abscess, continuing to force the solution through the root until it makes its appearance at the sinus opening. If it is found coming through too freely, lay the finger on the opening, thus causing the solution to be forced into any and every place around the root where the sac is, in this manner strangulating it and preventing the gathering of lymph, to be subsequently decomposed into pus. The abscess is thus destroyed. The gutta percha being an inert substance becomes encysted, nature thus assisted goes on and closes up the sinus; and you will have no more fear than if there had never been an abscess. It has one more recommendation, to the patient at least; it is painless. I have pursued this course of treatment since 1879, and, as far as I know, have not had a failure. I do not say that there has not been one; for you all very well know that they will not always come home to roost, however much we may wish them to. Hoping that when you find an abscess that will not yield to any other treatment, you will give this a fair trial, I shall have accomplished my purpose in presenting this plan for your consideration.—*Dental Register.*

* Read before the Cleveland Dental Society.

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TABLE OF CONTENTS.